ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 8
Issue 2
2023

PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

UDC 687.1.001.02:675.042

A RESEARCH OF CONSUMER OPINIONS IN FORMING THE IMPORTANT FACTORS OF FUR GARMENTS

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Abstract:

Objective. In this article, issues such as expanding the range of clothes made of black leather, which is considered our local raw material, the high price of fur clothing is a higher percentage than the cost of the finished product, the rational use of semi-finished fur products, and the creation of waste of almost 20% of the total amount of fur used in the enterprise.

Methods. In the article, consumer demand for black leather clothing: product quality and design is illustrated in a diagram.

Results. In our republic, economic analyzes were conducted to expand the range of clothes made of black leather and reduce the cost of the product.

Conclusion. In conclusion, we can say that while the demand for clothes made of black leather, which is considered our raw material, is stable and constantly growing, special attention is being paid to expanding the range of clothes made from black leather.

Keywords: Karakol, leather, assortment, design, consumer, tailors, technologists, designers. combination, production, consumer, technology.

Introduction. The head of our state pays special attention to the development of cattle breeding. In particular, during the visit of the President of Bukhara in February of last year, the local population made a large profit by selling livestock products to the whole world, it is necessary to restore the breeding and experience that is disappearing in this field, and to support shepherds and tailors. had emphasized.

Based on the need to develop the industry, on March 14, 2018, the Decision of the President of the Republic of Uzbekistan "On measures for the rapid development of the piracy industry" was adopted. In accordance with the decision, until January 1, 2023, subjects engaged in cattle breeding and livestock processing enterprises will import goods necessary for cattle breeding, which are not produced in the republic, according to the list to be approved in the prescribed manner. exempted from payment of customs duties (except customs clearance fees) for materials. In addition, the single land tax rates for livestock producers will remain unchanged until January 1, 2023.

The adoption of the President's Decision on "Measures for comprehensive development of the piracy network", adopted on August 16 of this year, showed how important the integral development of the sector is and was a logical continuation of the ongoing reforms.

Methods. Currently, the light industry in Uzbekistan is a multi-sectoral industrial complex, and the leather and fur industry occupies an important place among its main components.

The production of consumer products, that is, the production of leather and fur products, is growing day by day.

Nowadays, in the formation of market relations in our Republic, increasing the

competitiveness and quality of products in the natural leather production industry remains one of the main problems of today.

In connection with the transition to the market economy and the development of small and medium-sized businesses, the number of actively working women in the republic is increasing year by year. The nature of work for business women is diverse: presentations, conferences, roundtables, parties, trips, etc., which naturally affects the style and comfort of their clothes. Taking these factors into account, the sociological survey questionnaire includes the following slightly modified characteristics as biosocial characteristics of the respondents: education, employment status, income, convenience, height type and age. you can see in the corresponding diagrams.

Results. In order to solve this issue, a questionnaire survey was conducted among the residents of Bukhara region in January 2023. A total of 500 women aged 18-60 participated in the survey. Women of various professions (housewives, students, seamstresses, medical workers, sales representatives, teachers) were selected as respondents. According to the results of the survey, according to the types of activity of the respondents, 9% are housewives, 20% are representatives of the medical field, 22% are representatives of the trade field, and 18% are pedagogues, representatives of other fields (Fig. 1) [7,8].

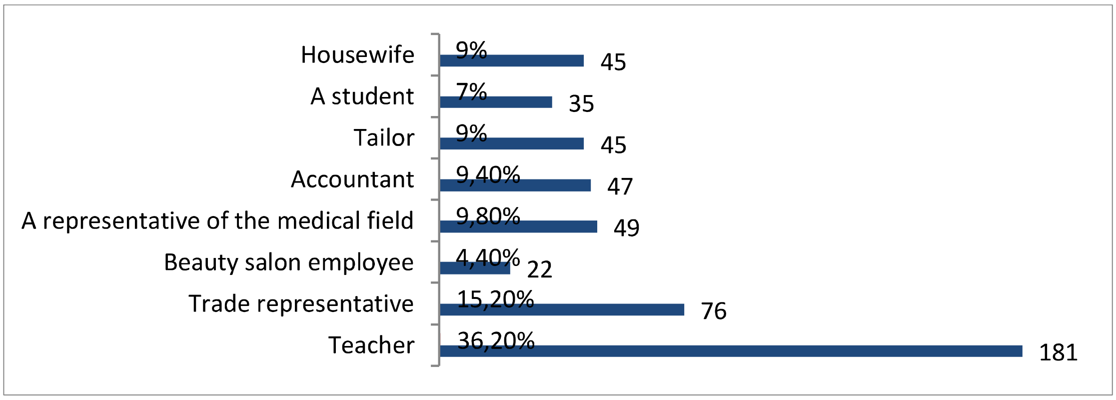
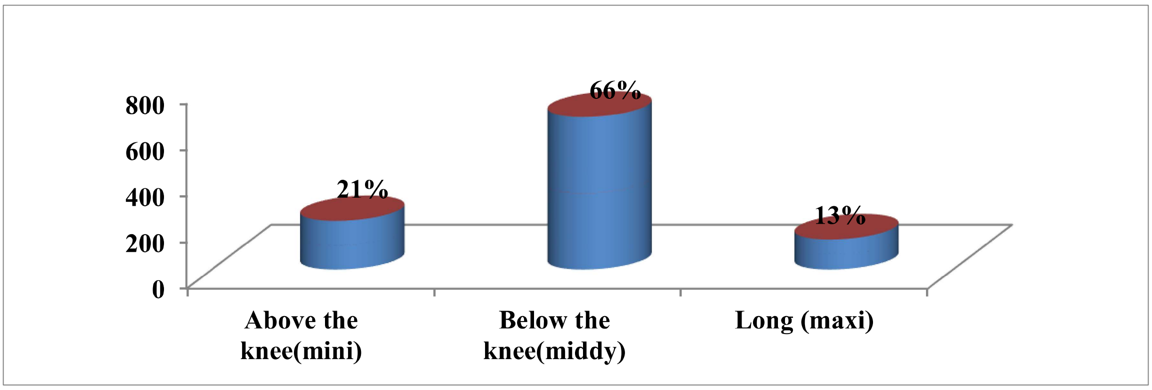
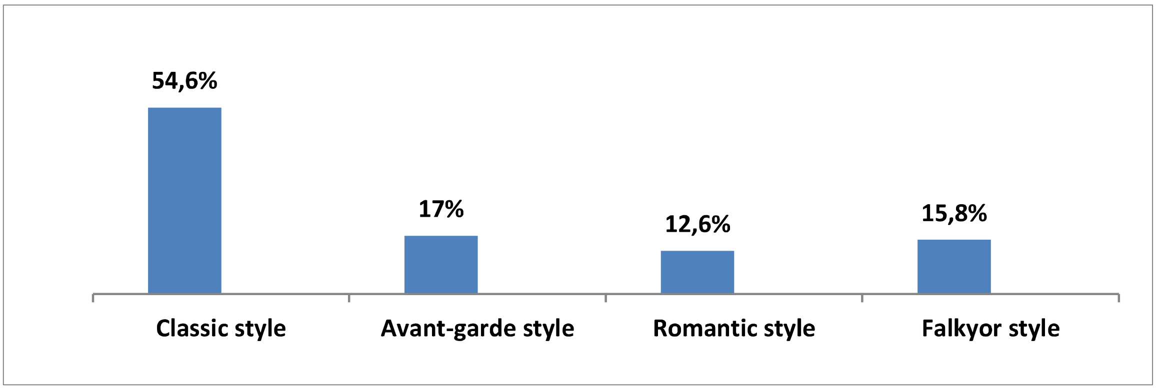


Figure 1. Activities of respondents

According to the length of clothing: above the knee (mini) 21%, below the knee (middi) 66%, long (maxi) 13%. According to clothing style b): classic style is 54.6%, avant-garde style is 17%, romantic style is 12.6%, folk style is 15.8%.



a)



b)

Figure 2. a) Clothing length b) Dress style

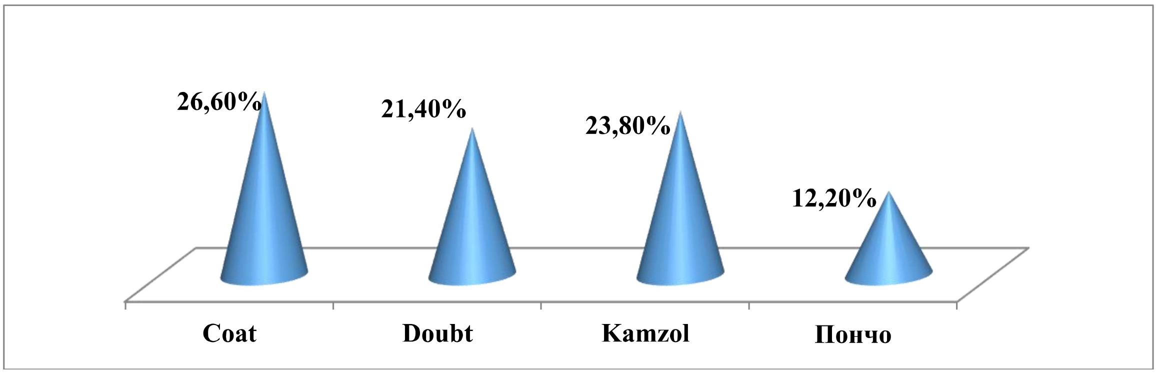
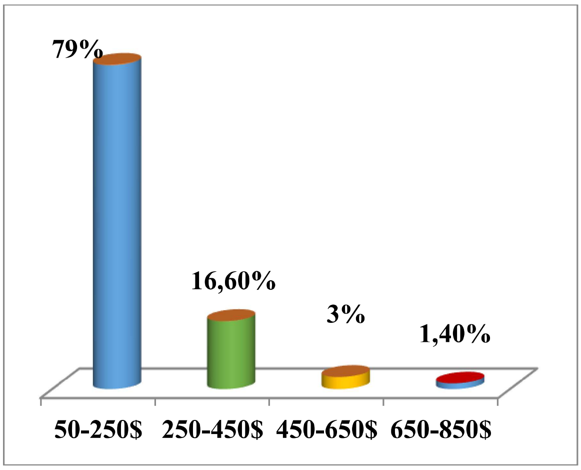
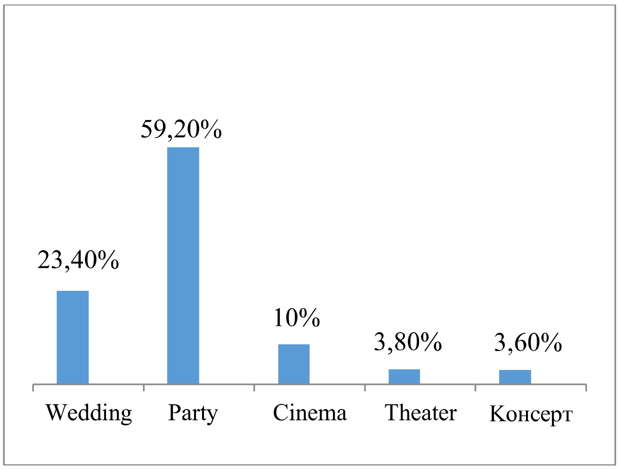


Figure 3. Types of women's outerwear from cowhide leather

In the next survey, 133 people (26.6%) prefer coats made of sheepskin, 107 (21.4%), 119 (23.8%), 119 (23.8%), ponchos (ponchos) , half coat is 80 (16%). So, based on the answers, mostly women prefer to wear buckskin coats.

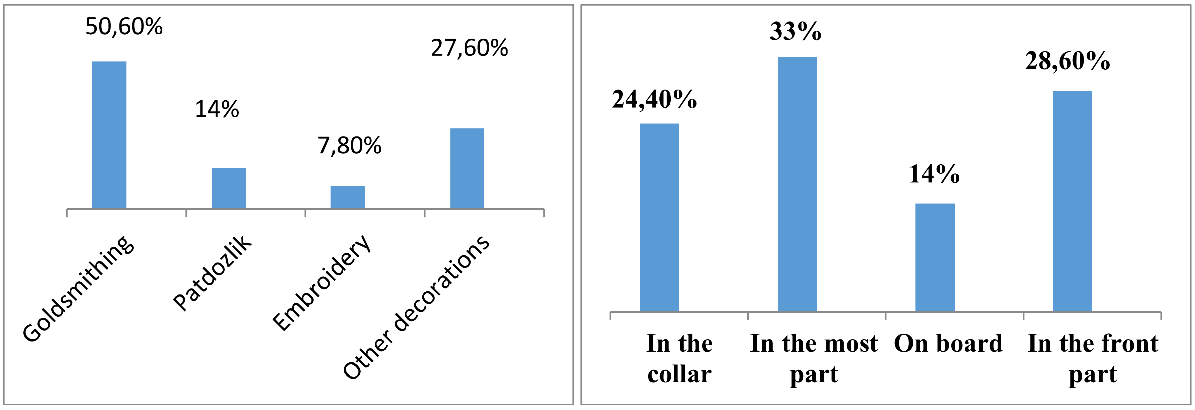




a) b)

Figure 4. a) Caracol leather women's outerwear price amount b) Places to wear women's outerwear made of cowhide leather

Caracol leather women's outerwear is 79% in the amount of 50-25$, 3% in the amount of 250-450$, 3% in the amount of 450-650$, 1.4% in the amount of 650-850$. According to the places where the clothes are worn, weddings are 23.4%, formal parties are 59.2%, movies are 10%, theaters are 3.8%, and concerts are 3.6%.



a) b)

Figure 5. a) Types of ornaments on women's outerwear made of cowhide leather; b) Location of types of ornaments on outerwear

According to the types of decoration in Karakol leather women's outerwear: goldsmithing is 50.6%, embroidery is 14%, embroidery is 7.8%, other decorations are 27.6%. According to the location of decoration types, it is 24.4% in the collar part, 33% in the hem part, 14% in the board part, and 28.6% in the front part.

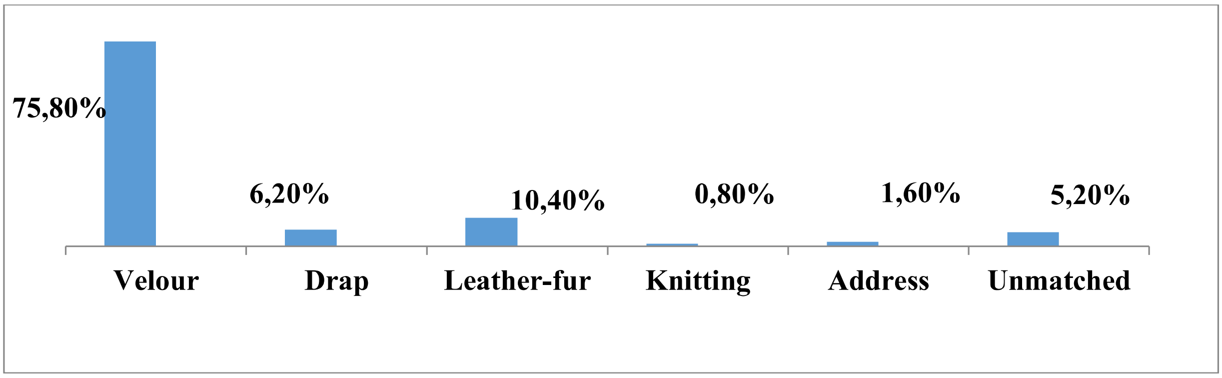


Figure 6. What kind of fabric is combined with women's outerwear made of cowhide leather

According to the fabric that the outerwear is combined with: velor 75.8%, drape 6.2%, leather fur 10.40%, knitwear 0.8%, adras 1.6%, do not want to combine 5.3%.

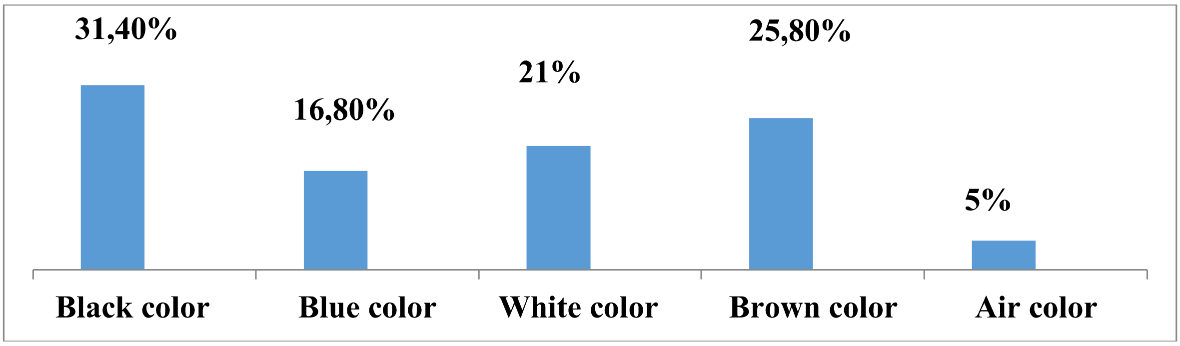


Figure 7. What is the color of women's top from caracol skin

According to the color of women's leather outerwear: black 31.4%, blue 16.8%, white 21%, brown 25.8%, air color 5%.

Discussions. The analysis of the results of the survey on the place of work and profession of the respondents showed that most of them are employees: economists, engineers, entrepreneurs, employees of the economy and government agencies. The majority of women prefer the classic style in clothes - 68.6%; romantic style (elegant, feminine things) is preferred by -6.2%; sports - 6.2%; vanguard - 6.5%;

When it comes to colors for fur, the majority of respondents preferred rich, muted colors and combinations. The choice of colors was related to the specific type of fur clothing, the age group of the respondent and the purpose of the products.

Eight colors are leading in the color scheme: white (18.2%), black, beige and silver (14.4%), brown (13.2%), gray (12%), yellow (2.7%), khaki (11%). It should be noted that the majority of respondents prefer short coats. Since most of the respondents are business women, the answers are relevant to their lifestyle.

For business meetings (restaurant, office) they prefer short coats that are compatible with two-piece suits: skirt-jacket, jacket-trousers, which can be combined with each other.

The results of the survey on the preferred types of clothing made of fur were distributed as follows: the most popular type among young and middle-aged women was a short coat (41.3%).

In many sociological studies, the following were considered as important characteristics of the respondents: education, employment status, convenience, age, income and height type.

Conclusion. When designing clothes from Karakol leather, he studied the needs and wishes of consumers through a questionnaire, analyzed the existing methods of design, and showed the need to significantly adjust the shape and design of fur products, which differ from analogues in their properties. New methods of designing clothes from Karakol leather should be based on, on the one hand, deep knowledge of the properties of materials, and on the other hand, on ergonomic studies of the dynamic properties of the product.

Modeling and designing clothes from Karakol leather has its own characteristics. In textile materials, only the model determines the number of details and parts of the clothes. In fur clothes, the number of parts, in addition to the style, is determined by the area of the sheepskin.

On the basis of marketing research of consumer demand, the main artistic and constructive features of the design of top products from Karakol were developed.

The matrix was developed and the leading collection of models of women's outerwear was formed.

Using the mathematical theory of the experiment, a new design of women's fur clothing was developed and reasonable design parameters were determined.

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UDC 687.1.001.02:675.042

LITERARY ANALYSIS NEW TECHNOLOGIES OF WOMEN'S OUTER CLOTHING FROM CARAKUL

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Abstract:

Objective. This article discusses: expanding the range of clothing from astrakhan, which is a local raw material, making a high percentage of the high cost of fur from the cost of the finished product, rational use of fur semi-finished products, making up 20 percent of inter-pattern attacks from the total area of fur used in the enterprise.

Methods. Based on the experience of the world's leading Western European designers in the use of innovative design methods, it was concluded that the use of modular design methods in the production of fur products is a promising direction for saving material resources, which allows organizing waste-free production. production and expansion of the range of fur.

Results. A study of the literature related to this study showed that many scientists and researchers in the field of light industry have been and are developing the scientific foundations, equipment and technologies of the clothing industry.

Conclusion. Thus, we can conclude that scientifically based research aimed at the design and production of women's fur clothing has not been carried out in practice. A study of the literature related to these studies showed that many scientists and researchers in the field of light industry have been and are developing the scientific foundations, techniques and technologies of the clothing industry.

Keywords: Karakol, leather, assortment, design, consumer, tailors, technologists, designers. combination, production, consumer, technology.

Introduction. The consumer and his wishes have always been the most important factor in shaping the demand for clothing. Thus, taking into account the characteristics of the material, principles are formed that correspond to the ideas of buyers about aesthetics, quality and especially comfort. Their diversity leads to freedom and democracy in fashion. This freedom also applies to fashion trends in fur clothing. Fur clothing should be not only beautiful, but also comfortable and practical. The main factors that determine the fashion for fur clothing are color, silhouette and product shape, proportions, details and finishes.

In our country, comprehensive measures are being taken to reduce labor intensity and energy costs in the production of finished leather products at fur enterprises, to develop resource-saving techniques and technologies that save resources, and certain results are achieved. In the Action Strategy for the Further Development of the Republic of Uzbekistan for 2017-2021 important tasks have been identified, including "…the improvement of equipment and technologies is the most important in the production of new types of competitive products based on resource-saving technologies.". In the implementation of these tasks, an important role, in particular, is played by the production of finished

products based on the efficient use of secondary material resources of fur enterprises.

Decree of the President of the Republic of Uzbekistan No. PP-4947 of February 7, 2017 “On the strategy of actions for the further development of the Republic of Uzbekistan”, No. PP-3693 of May 3, 2018 “Measures to stimulate growth and further develop the export potential of the leather, footwear and fur industry” This dissertation to a certain extent contributes to the implementation of the tasks set in the Decree "On Measures" and other regulations relating to this activity. [1,2].

Methods. With an analysis of the issues of improving the methods of fur coat decoration abroad, F.M. Parmon, G.I. Petushkova, T.V. Kozlova, E.Kh. Melikov, G.A. Bastov, L.V. Lopasova, G.P. Zaretskaya, M.Esina, E.G.Andreeva, G.M.Androsova, J..Yu.Koitova. Based on the experience of the world's leading Western European designers in the use of innovative design methods, it was concluded that the use of modular design methods in the production of fur products is a promising direction for saving material resources, which allows organizing waste-free production. production and expansion of the range of fur. The ways of introducing the technical practice of modular design into the design and manufacture of products from the fur of secondary material resources are revealed. Based on the analysis of scientific sources, the goals and objectives of the study were determined.

Scientists to improve the ergonomic properties of fur clothing Usenko V.A., Nikolaev S.D., Dalidovich A.S., Shalov I.I., Kudryavin Yu.A., Kuznetsova L.A., Kazakova Z.F., Kartseva A.A., Koketkin P.P., Andreeva E.G., Zolottseva L.F., Koblyakova E.B., Mukimov M.M. and others are doing it. The studies of these scientists have identified ways to improve the ergonomic properties of fur clothing, design and manufacture of products from fur secondary material resources, and introduce the technical practice of modular design.

So, for example, the main requirements for high fur products are: convenience, pleasant appearance, maintaining the size and shape of the product in clothes, if it is as convenient as possible. At the same time, the main requirements for fur products are that the product should be comfortable for a person actions, protect from exposure to cold, have a beautiful appearance. In addition to wearing comfort, the main thing is that the product has as beautiful an appearance as possible and is tightly packed with sufficient strength, it will be required that the pressure of the product on the human body is less than acceptable.

Results. A study of the literature related to this study showed that many scientists and researchers in the field of light industry have been and are developing the scientific foundations, equipment and technologies of the clothing industry. These scientists have been and are still engaged in improving the ergonomic properties of fur coats; Usenko V.A., Nikolaev S.D., Dalidovich A.S., Shalov I.I., Kudryavin Yu.L., Kuznetsova L.A., Kazakova Z.F., Kartseva A.A., Koketkin P .P., Andreeva E.G., Zolottseva L.F., Koblyakova A.V.V. Mukimov M.M. and others. At the same time, extensive scientific research is being carried out to improve the ergonomic properties of fur coats.

A study of the literature on this study showed that many scientists and researchers in the light industry have been and continue to be engaged in the development of scientific foundations, equipment and technologies for the clothing industry. Scientific research aimed at developing production technology, and not the topic, designing and modeling women's fur coats, has not been implemented in practice.

In the thesis of N.Zh. Ergashova [1] "Analysis of the main directions for improving the process of artistic design of fur coats in conditions of low-cost technologies" considered the theory and

practice of designing fur products using energy-saving technologies.

Analytical study of the main issues of theory and practice of non-standard solutions for the decoration of fur coats;

Determining the dynamics of the modern fur industry with an innovative direction;

Development of methods for the artistic design of clothing based on information systems and the principles of combinatorics of designing modules;

A comprehensive study of the properties that determine its quality during the subsequent processing of various semi-finished fur products based on the use of developed and improved design methods;

Building a mathematical model for optimizing the selection of fur linings for products, taking into account their operational characteristics;

Dissertation of Myshkina S.M. [2] titled "Study of the shaping and design parameters of fur as a database of modular design" is devoted to the study of the shaping properties and design of the fur. 2018-2021 by world famous contemporary designers as an analysis of the most traditional forms and methods of shaping fur in general. more than 200 models from 23 collections of the season have been studied. A methodology for studying the design of fur products has been developed, taking into account the parameters characterizing the traditional forms of products, their interdependence and frequency of distribution, as well as the principles of innovative fur design.

Dissertation by N.Sh.Temirova [3] “Creating a method for sewing outerwear for women from natural fur” There are several ways of sewing fur coats, the most popular of which are the methods of transverse and longitudinal cutting. between themselves. Cut and connected in this form, the skins are distinguished by the invisibility of the seams from the side of the hair follicle.

When designing technological processes for tailoring, a systematic approach was used, designing fur semi-finished products, mathematical modeling, peer review, factor analysis and processing of experimental results.

Discussions .A study of the literature on these studies showed that many scientists and researchers in the light industry have been and continue to develop the scientific foundations, techniques and technologies of the clothing industry. Scientific research aimed at the development of production technology, and not the topic, the design and modeling of leather and fur products, has not been implemented in practice.

The expansion of the range of finished products should be addressed in a comprehensive manner in accordance with a scientific approach at the stage of preparing raw materials and designing finished products based on a comprehensive analysis of the "man-clothing-environment" system. At the same time, it is cost-effective and efficient to create products focused on the use of local raw materials, taking into account market requirements and current fashion trends.

The consumer and his wishes have always been the most important factor in shaping the demand for clothing. Thus, taking into account the characteristics of the material, principles are formed that correspond to the ideas of buyers about aesthetics, quality and especially comfort. Their diversity leads to freedom and democracy in fashion. This freedom also applies to fashion trends in fur clothing. Fur clothing should be not only beautiful, but also comfortable and practical. The main factors that determine the fashion for fur clothing are color, silhouette and product shape, proportions, details and finishes.

Conclusion. Thus, it can be concluded that scientifically based research aimed at the design and production of women's fur clothing has not been carried out in practice. A study of the literature related to these studies showed that many scientists and researchers in the field of light industry have been and are developing scientific fundamentals, techniques and technologies of the clothing

industry. Instead of the subject, scientifically based research aimed at developing the technology of production, design and modeling of leather and fur clothing has not been carried out in practice.

Expansion of the range of finished products should be addressed in a comprehensive manner in accordance with the scientific approach at the stage of preparation of raw materials and design of finished products based on a comprehensive analysis of "man-clothes-environment" system. At the same time, it is cost-effective and efficient to create products that are quickly introduced into the network, taking into account market requirements and current fashion trends, focused on the use of local raw materials.

Domestic and foreign industry produces astrakhan of different colors using simple and different patterns, for example, using a stencil method. The range of fur coats has been expanded with the use of colored astrakhan with specially designed hairstyles, improved product design and improved cut quality.

Modern technologies help to create original fur products and make-up: for example, clothes from the remains of fur of different colors and textures, fur earrings decorated with animal beaks, flowers and butterflies from painted mink, mink pom-poms. , fur brushes, applications and much more.

Because the study of the operational characteristics of karakul made it possible to determine the feasibility of using 5-day-old karakul for the production of fur products. it is not very expensive, has good hygienic and operational properties, which allows developing high-quality and consumer-friendly products.

The proposed method, designed to standardize and unify the parameters of women's fur designs, will increase labor productivity by 45-50%.

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STUDY OF AERODYNAMIC CHARACTERISTICS OF COTTON FIBER IN SEPARATOR OF PNEUMO-MECHANICAL SPINNING MACHINE

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Abstract:

Objective. In this article, the movement of fibers in the air channel and the rotor in the pneumomechanical spinning machine was studied. In the experimental work, the uniformity and stability of the velocity field of each channel for moving fibers in an aerodynamic device were checked. In this case, the airflow speed was changed from 5 m/s to 30 m/s. Differential equations of motion along the OX and OY axis were created taking into account the air resistance.

Methods. When determining the movement of fibers in a conical channel, the total speed was divided into components, constant values were found, and general equations of motion were derived. Also, time-dependent graphs of the movement of fibers in a conical channel along the OX axis on different surfaces, and time-dependent graphs of the movement along the OX axis at different speeds were obtained.

Results. The results of the research showed that the time-dependent graphs of the movement of fibers along the OX axis in the conical channel on different surfaces, and the time-dependent graphs of the speed *s* in the channel were obtained.

Conclusion. The results of the study showed that when the time-dependent graph of the movement of the fibers in the conical channel along the OX axis on different surfaces $S_1=14{,}51$, $S_2=12{,}56$, $S_3=10{,}75$ was obtained, the fibers on the small surface were straight. When the flow rate is high, a good result was obtained at high speed when the time-dependent graph of the speed of $\vartheta_1 = 30 m/s$ $\vartheta_2 = 25 m/s$ $\vartheta_3 = 20$ *m/s* was obtained in the channel.

Keywords: pneumomechanical spinning, separator, air channel, fiber, chamber, cone.

Introduction. The pneumomechanical spinning technique is widely used in the textile industry due to its excellent economic perspective. The rotor is the most important component of the pneumomechanical spinning machine, and its speed has a significant impact on the yarn quality. In the study of Chen and Slater [1], the flow behavior in the rotor changes significantly with increasing speed. Kocyo and Lawrence [2] conducted studies on twisting mechanics and rotor spinning under different operating conditions. The effect of rotor speed and geometrical parameters on airflow was analyzed by Xiao et al. [3] and they found that the angular velocity and the slip angle, the good axisymmetry of the spiral

structure in the meridional plane of the rotor is reached.

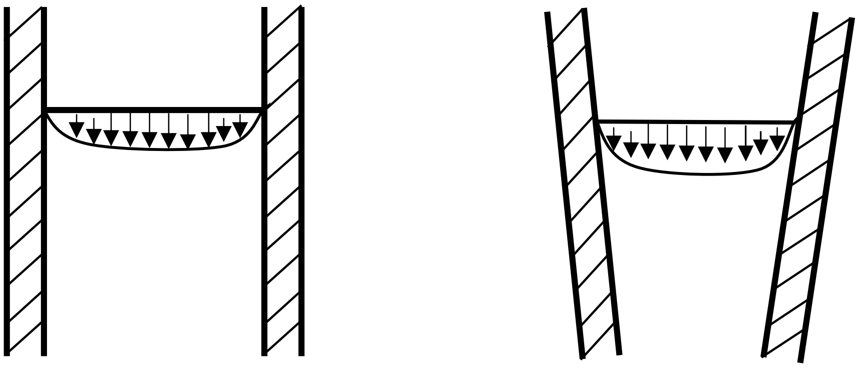
Methods and results. The entire experiment is reduced to measuring force and measuring flow rate, where the flow rate is averaged. The research consists of determining the coefficient of direct resistance S_x, researching the pulling action of cotton fibers, and the effect of density. At the same time, two types of channel shapes were chosen for blowing fibers:

- rectangular channel;
- narrowing channel (confuser type)

Which of the selected channels is the most suitable for the transportation of cotton fibers was compared.

Before the start of the experiments, the uniformity and stability of the velocity field of each channel for blowing fibers in an aerodynamic device were checked. Experiments have shown that the velocity profile in the suspended fiber zone satisfies the conditions of uniformity both in a rectangular channel (Fig. 1a) and in a narrow channel (Fig. 2b).

The airflow speed was varied from 5 m/s to 30 m/s by gradually increasing the fan rotation speed. The measurement range is 30^0 C. The flow rate was determined using a Pitot tube connected to a micromanometer Benetech GM 8903 Thermoanemometer.



a) b)

Figure 1. Fiber channel located in the separator. a) – rectangular channel, b) – conical channel

In the cross-section of the fiber-blowing chamber, the total pressure distribution force was measured using a microtube with an inlet diameter of 6 mm, and the statistical pressure was measured using a statistical pressure tube. At the same time, atmospheric pressure-P_a; ambient temperature -t; relative humidity-Rh was measured.

Calculation of the speed of the flow in different sections was carried out by dynamic measurement of the dynamic pressure P using a pitot tube, and the statistical pressure P according to the static formula [4-8].

$$V = \xi\sqrt{\frac{2k\sin\alpha(h-h_0)\gamma}{\rho}} \quad (1)$$

here

ξ- calibration coefficient equal to 0.98;

k- calibration coefficient of the equipment;

α- micromanometer tube liquid slope angle;

ho- the initial indicator of the micromanometer;
ρ- air density, kg/cm^3;
γ- micromanometer liquid density, g/cm^3;

The density value of alcohol was determined with a simple hydrometer with an accuracy of 0.0001 g/cm3. The relative deviation of density determination for alcohol ranges from 0.800 to 0.820 g/cm3, and is equal to

$$\delta_c = \frac{\Delta\gamma}{\gamma} = \frac{0.001}{0.8} = 0.125\% \qquad (2)$$

The relative error in determining the angle of inclination of the pipe, including the error in the installation of the crossbar, does not exceed 0.2%, and therefore

$$\delta_c = \frac{\Delta \sin\alpha}{\sin\alpha} \simeq 0.2\% \qquad (3)$$

All experiments were performed in triplicate. The required number of measurements was calculated as follows: let δ_s be the systematic error determined by the accuracy class of the instrument or another factor. It is recommended to reduce the random error to such an extent that the error should be less than the systematic one. For this, the value of the absolute error should be smaller than ΔX , δ_s, i.e

$$\Delta\bar{X} \le \frac{\delta_c}{3}; \qquad (4)$$

Taking into account the air resistance, the following expression (1) was created as a differential equation of motion along the OX axis.

Assuming that there is a constant cross-section of the movement channel of the fibers, a coordinate system corresponding to the wall of the movement channel of the fiber on the OX axis was selected.

It was observed that the speed changes in different values of the surfaces over time. The motion of the fibers in the conical tube is integrated with the differential equation along the X-axis. As a result, the speed along the X-axis is determined. It depends on (m) fiber mass, (S_y) drag coefficient, (v_x) air velocity, (S) different surfaces of the conical channel, (α) angle, and (t) time.

$$\frac{dv_x}{v_x^2\cos^2\alpha + v_n^2} = -\frac{C_x S\rho}{2m}\cdot dt$$

$$\frac{dv_x}{v_x^2 + \left(\frac{v_n}{\cos\alpha}\right)^2} = -\frac{C_x S\rho}{2m}\cdot\cos^2\alpha\cdot dt$$

$$\frac{\cos\alpha}{v_n}\, arctg\left(\frac{v_x\cdot\cos\alpha}{v_n}\right) = -\frac{C_x S\rho}{2m}\cos^2\alpha\cdot t$$

$$arctg\left(\frac{v_x}{v_n}\cos\alpha\right) = -\frac{C_x S\rho\cdot v_n\cdot\cos\alpha}{2m}\cdot t$$

$$v_x = -tg\left(\frac{C_x S\rho\cdot v_n\cdot\cos\alpha}{2m}\cdot t\right)\cdot v_n\cdot\cos\alpha \qquad (5)$$

By differentiating the received equation (5) by time, the equation of the movement trajectory of the fibers along the X-axis (6) was obtained. It depends on (m) fiber mass, (S_y) drag coefficient, (r) air density, (v_n) velocity, (S) different surfaces of the conical channel, (α) angle, and (t) time.

$$x = ln\left(\cos\left(\frac{C_x S\rho\cdot v_n\cdot\cos\alpha\cdot t}{2m}\right)\right)\cdot v_n\cdot\cos\alpha\cdot\left(\frac{2m}{C_x S\rho\cdot v_n\cdot\cos\alpha\cdot t}\right)$$

$$x = ln\left(\cos\left(\frac{C_x S\rho\cdot v_n\cdot\cos\alpha\cdot t}{2m}\right)\right)\cdot\left(\frac{2m}{C_x S\rho\cdot t}\right) \qquad (6)$$

Equations for the dependence of breaking force on speeds are derived.

Results.

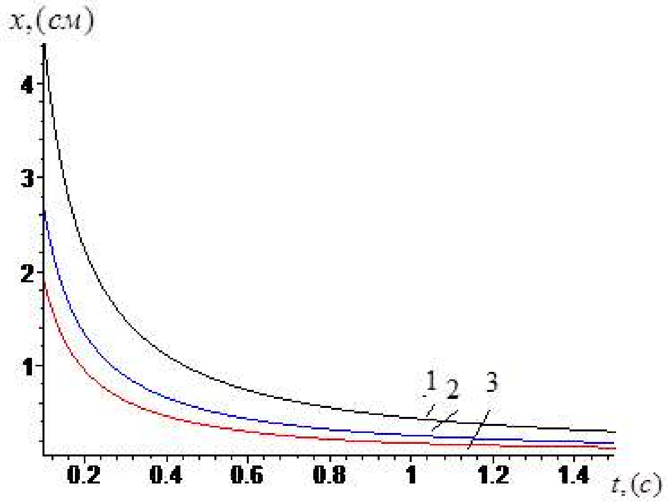


Figure 2. Time-dependent graph of the movement of fibers in a conical channel along the OX-axis on different surfaces S_1=19.6, S_2=12,6, S_3=7.1

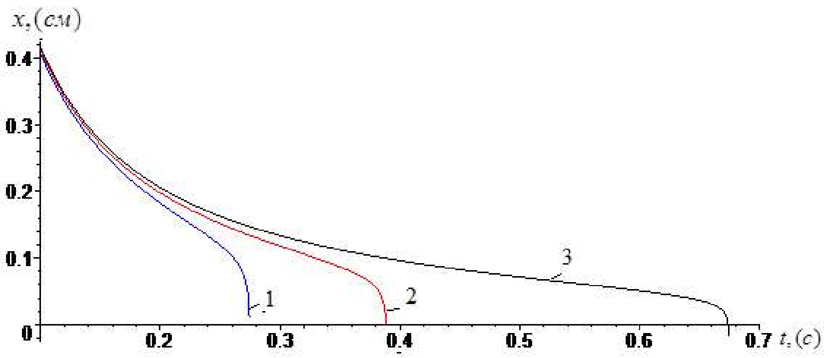


Figure 3. Time-dependent graph of the movement of fibers along the OX-axis in a conical channel at different speeds of $\vartheta_1 = 30$m/s $\vartheta_2 = 25$m/s $\vartheta_3 = 20$ m/s

Conclusion. In the research work, the movement of fibers in the air channel and the rotor in the pneumomechanical spinning machine was studied. In the experimental work, the uniformity and stability of the velocity field of each channel for moving fibers in an aerodynamic device were checked. In this case, the airflow speed was changed from 5 m/s to 30 m/s. Taking into account the air resistance, differential equations of motion along the OX axis were created. When determining the movement of fibers in a conical channel, the total speed was divided into components, constant values were found, and general equations of motion were derived. Also, time-dependent graphs of the movement of fibers in a conical channel along the OX axis on different surfaces, and time-dependent graphs of the movement along the OX axis at different speeds were obtained. The results of the study showed that when the time-dependent graph of the movement of the fibers in the conical channel along the OX axis on different surfaces *S_1=14,51, S_2=12,56, S_3=10,75* was obtained, the fibers on the small surface were straight. When the flow rate is high, a good result was obtained at high speed when the time-dependent graph of the speed of $\vartheta_1 =$ *30m/s* $\vartheta_2 =$ *25m/s* $\vartheta_3 =$ *20 m/s* was obtained in the channel.

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RESEARCH OF THE MOVEMENT OF FIBERS IN THE CONFUSION BETWEEN THE AIR CHANNEL AND THE ROTOR IN A PNEUMO-MECHANICAL SPINNING MACHINE

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Abstract:

Objective. In this paper, we conducted research based on a new experimental approach to describe the airflow in a rotor-spinning machine experimentally. This article studied the movement of fibers in the air channel and the rotor in the pneumomechanical spinning machine. In this case, the airflow speed was changed from 5 m/s to 30 m/s. Differential equations of motion along the OX and OY axis were created considering the air resistance.

Methods. When determining the movement of fibers in a conical channel, the total speed was divided into components, constant values were found, and general equations of motion were derived. Also, time-dependent graphs of the movement of fibers in a conical channel along the OY axis on different surfaces, and time-dependent graphs of the movement along the OY axis at different speeds were obtained.

Results. The results of the study showed that the movement of fibers in the conical channel along the OY axis is a time-dependent graph on different surfaces $S_1=14,51$, $S_2=12,56$, $S_3=10,75$, in the channel time-dependent graphs at a speed of $\vartheta_1 = 30 m/s$ $\vartheta_2 = 25 m/s$ $\vartheta_3 = 20\ m/s$ were obtained.

Conclusion. The results of the study showed that when the time-dependent graph of the movement of the fibers in the conical channel along the OY axis was obtained on different surfaces $S_1=14,51$, $S_2=12,56$, $S_3=10,75$, the fibers on the small surface were straight. When the velocity is high, the time-dependent graph of the speed of $\vartheta_1 = 30 m/s$ $\vartheta_2 = 25 m/s$ $\vartheta_3 = 20\ m/s$ in the channel was obtained at high speed.

Keywords: pneumomechanical spinning, separator, air channel, fiber, chamber, cone.

Introduction. Some studies have been done on the airflow in the rotor-spinning machine's confusor. Lawrence and Chen [1, 2] used a high-speed camera

to photograph the fiber morphology during fiber transmission and optimized the design of the confusor combined with an empirical formula. Kong and Platfoot [3, 4] found that changing the geometric dimensions of the confusor or the speed of the opening roller affects the shape of the airflow in the confusor. The airflow then changes the configuration of the fibers flowing inside the channel. They also studied the influence of the rotational zones on the fiber configuration during transmission within the channel. Lin et al. [5, 6, 7] reviewed the impact of the geometrical parameters of the confusor and the spatial position between the rotor and the channel on the airflow characteristics in the rotor-spinning machine.

Methods and results. In the cross-section of the fiber-blowing chamber, the full pressure distribution force was measured using a microtube with an inlet diameter of 6 mm, and the statistical pressure was measured using a statistical pressure tube. At the same time, atmospheric pressure-P_a; ambient temperature -t; relative humidity-Rh were measured.

Calculation of the speed of the flow in different sections was carried out by dynamic measurement of dynamic pressure R using a pitot tube, and static pressure R according to the static formula [8, 9].

$$V = \xi\sqrt{\frac{2k\sin\alpha(h-h_0)\gamma}{\rho}} \tag{1}$$

here
ξ-calibration coefficient equal to 0.98;
k- calibration coefficient of the equipment;
α- micromanometer tube liquid slope angle;
ho- the initial indicator of the micromanometer;
ρ- air density, kg/cm^3;
γ- micromanometer liquid density, g/cm^3;

The density value of alcohol was determined with a simple hydrometer with an accuracy of 0.0001 g/cm3. The relative deviation of density determination for alcohol ranges from 0.800 to 0.820 g/cm3, and is equal to

$$\delta_c = \frac{\Delta\gamma}{\gamma} = \frac{0.001}{0.8} = 0.125\% \tag{2}$$

The relative error in determining the angle of inclination of the pipe, including the error in the installation of the crossbar, does not exceed 0.2%, and therefore

$$\delta_c = \frac{\Delta\sin\alpha}{\sin\alpha} \simeq 0.2\% \tag{3}$$

All experiments were performed in triplicate. The required number of measurements was calculated as follows: let δ_s be the systematic error determined by the accuracy class of the instrument or another factor. It is recommended to reduce the random error to such an extent that the error should be less than the systematic one. For this, the value of the absolute error should be smaller than ΔX , δ_s, i.e

$$\Delta\bar{X} \leq \frac{\delta_c}{3}; \tag{4}$$

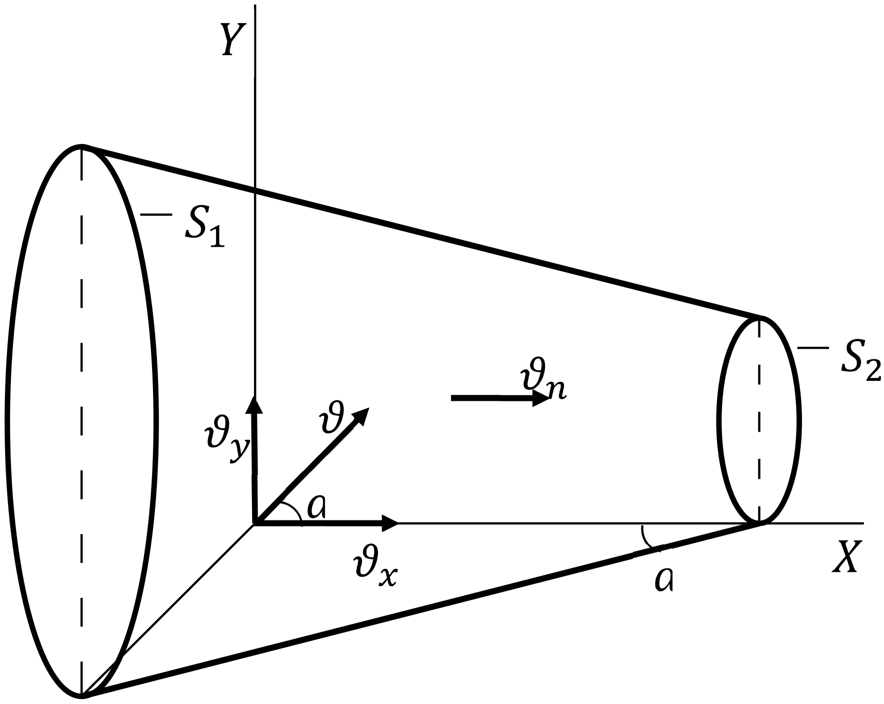

Figure 1. Scheme of movement of fibers in the channel

Taking into account the air resistance, the following expression (1) was created as a differential equation of motion along the OY axis.

Assuming that there is a constant cross-section of the movement channel of the fibers, a coordinate system corresponding to the wall of the movement channel of the fiber on the OY axis was selected. Taking into account the air resistance, the following expression (1) was created as a differential equation of motion along the OY axis.

$$m\cdot\frac{d\vartheta_y}{dt}=\frac{1}{2}\cdot C_y\cdot S\cdot\rho\cdot\vartheta_y^2\cdot\sin^2\alpha$$
$$m\cdot\frac{d\vartheta_x}{dt}=-\frac{1}{2}\cdot C_x\cdot S\cdot\rho\cdot(\vartheta_x^2\cdot\cos^2\alpha+\vartheta_n^2) \quad (5)$$

Expression (5) represents the differential equations of the movement of fibers along the channel. Here, (S) are the surfaces through which the fibers flow, the resistance coefficient (r), the air density, and (m) the mass of the fibers.

$$\frac{dv_y}{v_y^2}=\frac{C_y\rho S\cdot\sin^2\alpha}{2m}\cdot dt$$

In determining the movement of fibers in the conical channel, the total speed was divided into components. When constructing a differential equation of motion, differential equations are integrated, initial and boundary conditions are used, invariant values are found, and general equations of motion are derived.

$$v_y=-\frac{2m}{C_y\rho S\cdot\sin^2\alpha\cdot t} \quad (6)$$

First, the rate of change over time was determined in the differential equation of motion along the Y-axis (6).

In determining the rate of change with time in the differential equation of motion along the Y axis, (m) the mass of the fiber, (Sy) the resistance coefficient, (r) the air density, (S) the surface of the conical channel, (a) the angle and (t) depends on time.

$$Y = -\frac{2m}{C_y \rho S \cdot \sin^2 \alpha} \cdot lnt \tag{7}$$

By differentiating the obtained equation (6) with respect to time, the equation of the movement trajectory of fibers along Y was derived (7). Here (m) is the fiber mass, (S_y) is the drag coefficient, (r) is the air density, (S) is the different surface area of the conical channel, (α) is the angle, and (t) depends on time.

In the next case, it was observed that the speed of the surfaces changes in different values over time. The motion of the fibers in the conical tube is integrated with the differential equation along the X-axis. As a result, the speed along the X-axis is determined. It depends on (m) fiber mass, (S_y) drag coefficient, (v_x) air velocity, (S) different surfaces of the conical channel, (α) angle, and (t) time.

$$\frac{dv_x}{v_x^2 \cos^2 \alpha + v_n^2} = -\frac{C_x S \rho}{2m} \cdot dt$$

$$\frac{dv_x}{v_x^2 + \left(\frac{v_n}{\cos \alpha}\right)^2} = -\frac{C_x S \rho}{2m} \cdot \cos^2 \alpha \cdot dt$$

$$\frac{\cos \alpha}{v_n} \, arctg \left(\frac{v_x \cdot \cos \alpha}{v_n}\right) = -\frac{C_x S \rho}{2m} \cos^2 \alpha \cdot t$$

$$arctg \left(\frac{v_x}{v_n} \cos \alpha\right) = -\frac{C_x S \rho \cdot v_n \cdot \cos \alpha}{2m} \cdot t$$

$$v_{\mathrm{x}} = -tg \left(\frac{C_x S \rho \cdot v_n \cdot \cos \alpha}{2m} \cdot t\right) \cdot v_n \cdot \cos \alpha \tag{8}$$

By differentiating the obtained equation (8) by time, the equation of the movement trajectory of the fibers along the X-axis (9) was obtained. It depends on (m) fiber mass, (S_y) drag coefficient, (r) air density, (v_n) velocity, (S) different surfaces of the conical channel, (a) angle, and (t) time.

$$x = ln \left(\cos \left(\frac{C_x S \rho \cdot v_n \cdot \cos \alpha \cdot t}{2m}\right)\right) \cdot v_n \cdot \cos \alpha \cdot \left(\frac{2m}{C_x S \rho \cdot v_n \cdot \cos \alpha \cdot t}\right)$$

$$x = ln \left(\cos \left(\frac{C_x S \rho \cdot v_n \cdot \cos \alpha \cdot t}{2m}\right)\right) \cdot \left(\frac{2m}{C_x S \rho \cdot t}\right) \tag{9}$$

Equations for the dependence of breaking force on speeds are derived.

Results.

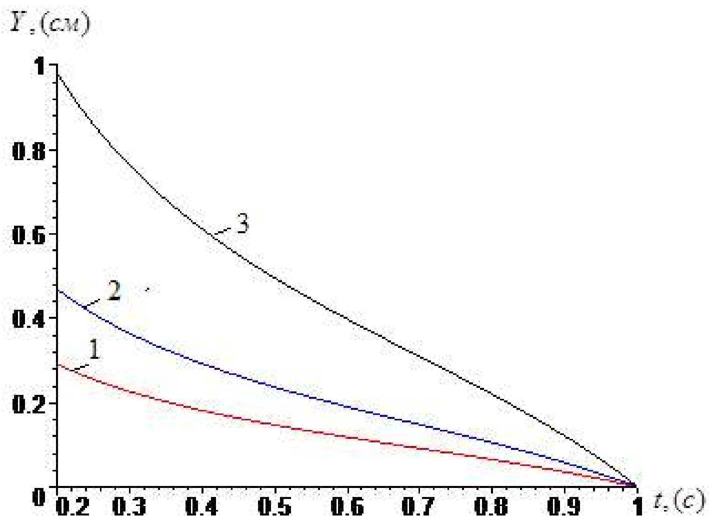

Figure 2. Time-dependent graph of the movement of fibers in a conical channel along the OY axis on different surfaces S_1=19.6, S_2=12,6, S_3=7.1

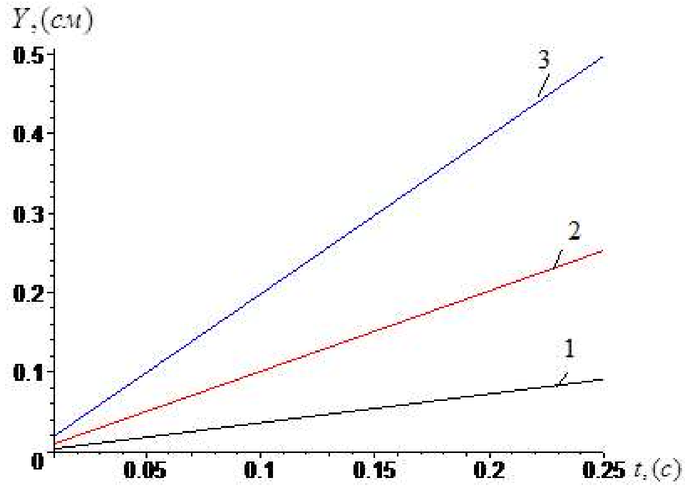

Figure 3. Time-dependent graph of the movement of fibers in a conical channel along the OY axis at different speeds of $\vartheta_1 = 30$m/s $\vartheta_2 = 25$m/s $\vartheta_3 = 20$ m/s

Conclusion. In the research work, the movement of fibers in the air channel and the rotor in the pneumomechanical spinning machine was studied. In the experimental work, the uniformity and stability of the velocity field of each channel for moving fibers in an aerodynamic device were checked. In this case, the airflow speed was changed from 5 m/s to 30 m/s. Taking into account the air resistance, differential equations of motion along the OY axis were created. When determining the movement of fibers in a conical channel, the total speed was divided into components, constant values were found, and general equations of motion were derived. Also, time-dependent graphs of the movement of fibers in a conical channel along the OY axis on different surfaces were obtained. The results of the study showed that when the time-dependent graph of the movement of the fibers in the conical channel along the OY axis was obtained on different surfaces $S_1=14,51$, $S_2=12,56$, $S_3=10,75$, the fibers on the small surface were straight. When the velocity is high, the time-dependent graph of the speed of $\vartheta_1 = 30m/s$ $\vartheta_2 = 25m/s$ $\vartheta_3 = 20$ *m/s* in the channel were obtained at high speed.

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ANALYSIS OF TECHNOLOGICAL PARAMETERS AND PHYSIC-MECHANICAL PROPERTIES OF INTERLOCK KNITTED FABRIC KNITTED FROM COTTON-NITRON YARN

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Abstract:

Objective. For the purpose of effective use of local raw materials in the scientific work was carried out on the technological indicators and physical-mechanical properties of interlock fabric from cotton-nitron yarn. The purpose of research is develop and recommend the new technology of production of interlock knitted fabric with high heat and shape retention properties by using mixed yarn from nitron and cotton.

Method. Theoretical analysis and synthesis methods, the research of the knitting process was used, and experimental researches in the production conditions by Hanma (China) circular knitting machine were carried.

Results. A positive result of the properties of the fabric was achieved by the creation of the technology of knitting interlock fabric using cotton-nitron yarn.

Conclusion. Experimental samples of interlock knitted fabrics obtained from spun cotton and cotton-nitron yarns were taken and their technological indicators and physical-mechanical properties were analyzed.

Keywords: knitting, cotton-nitron, interlock, air permeability, abrasion, rupture, deformation.

Introduction. Double knitted interlock fabric is a derivative of rib stitch. The “Interlock” word is an English word that means "to cross in the form of a cross" and

it consists of two rib stitch rows, the protuberances of which cross each other in the form of a cross (Figure 1).

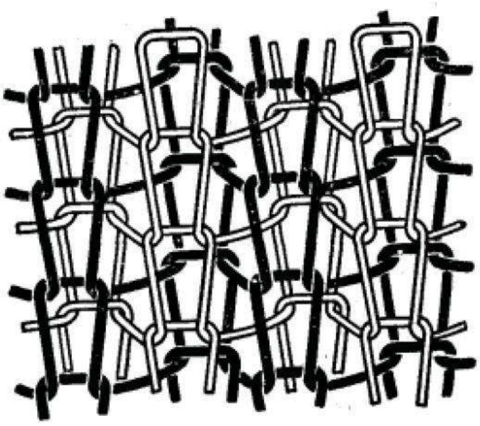

Figure 1. The structure of interlock stitch

As practice shows, interlock stitch is widespread in the manufacture of knitwear, as it has the most stable structure. A number of studies by foreign scientists are devoted to the study of the parameters and properties of interlock.

The aim of this study was to investigate the effect of knitting parameters on the moisture management and air permeability of the interlock fabrics. Samples were produced at two different knitting gauges, each with three different stitch lengths. It was found that the fabric mass per square metre increases by increasing machine gauge and decreasing the stitch length, whereas the fabric thickness and porosity increase at these settings. It was further concluded that the loosely knitted fabric samples with higher amount of entrapped air exhibit good air permeability but poor moisture management properties [1].

The knitting parameters and the type of structure not only affect the comfort but also the performance properties of the knitted fabrics [2]. Knitting machine gauge and the knitting stitch length are the two fundamental knitting parameters that directly affect all structure related properties of the knitted fabric [3-4]. Singh et al. [5] studied the effect of stitch length of jersey fabric and reported that stitch length affects its shrinkage in a direct manner. Available literature does not reveal the effect of knitting stitch length and machine gauge on the 3D moisture management and air permeability of the interlock knitted fabrics. The aim of this work is to fill this gap by investigating these key thermo-physiological comfort properties of the interlock fabrics.

There are cotton, nitron, and also mixed cotton-nitron yarn are made in Uzbekistan. This types of yarn have good consumer properties. So it is actual to investigate knitting ways from these types yarn and analysis of technological parameters and physic-mechanical properties of interlock knitted fabric knitted from cotton-nitron yarn.

Methods. Unraveling of the knitted fabric. Interlock is unravel in the opposite direction to the knitting direction, like a rib stitch. The elasticity of the interlock is slightly less than the elasticity of the rib, which can be explained by the uniqueness of the structure of the interlock fabric.

Thickness. The thickness of the interlock is equal to the thickness of the compound and is directly proportional to the linear density of the yarns. For example, the thickness of the interlock from cotton yarn (coefficient of expansion α= 90÷112) is equal to:

$$M = \frac{7{,}2 * T}{1000}, \qquad \alpha = \frac{K\sqrt{T}}{31{,}6}$$

where, T is the linear density of the thread (yarn), tex;

K is the number of occurrences.

The thickness of the interlock stitch from artificial yarns is equal to that of the thread when the coefficient of friction is a=16÷20:

$$M = \frac{4{,}3 * T}{1000}$$

Surface density. Interlock surface density is determined by the rib surface density formula:

$$m = \frac{0{,}8 * P_Г * P_В}{\frac{1000}{T}} = \frac{0{,}8 * P_Г * P_В * T}{1000}$$

Loop thread length. The length of the loop thread of the interlock fabric is formed by the sum of the lengths of the sections. Interlock loop thread length is slightly different than glad and rubber loop thread length, because the length of the interlock loop spacer is slightly different than the length of the rubber and glad loop spacers. Based on this, the loop thread length of the interlock fabric can be calculated using the following formulas. Loop thread length for interlock stitch from cotton thread:

$$L = \frac{90}{P_Г} + \frac{100}{P_В} + 3{,}6\,F \qquad \text{Or} \qquad L = \frac{110}{P_Г} + \frac{140}{P_В} - 2{,}2\,F$$

For an interlock stitch from artificial yarns:

$$L = \frac{90}{P_Г} + \frac{100}{P_В} + 1{,}5\,F$$

In addition, the length of the loop thread can also be determined by the filling factor:

L = *б*f*

b - is the filling factor.

f - is the minimum thickness for cotton thread determined by the formula:

$$f = \frac{0.92}{\sqrt{\frac{1000}{T}}}$$

The filling factor is taken depending on the types of products. It is taken between 29÷31 for the range of inner and sports products, and between 27÷28 for outerwear.

Horizontal density. The horizontal density of the interlock fabric depends on the length of the loop thread.

The thicker the thread and the longer the length of the loop thread, the lower the knitting density and the larger the amount of loop pitch A. The horizontal density of the interlock fabric is higher than that of the tire, because the adjacent loops the interlock fabric are shifted vertically by half a loop relative to each other. The loop pitch of the interlock fabric at the normal length of the loop thread can be determined from the following formula:

$$A = 3{,}3F + 0{,}15$$

The next formula for the pitch of the loop gives its amount, taking into account the length of the loop thread:

$$A = 2{,}7F + 0{,}05L + 0{,}08$$

Horizontal density

$$P_{Г} = \frac{50}{A}$$

Vertical density. The vertical density depends on the length of the loop thread and the thickness of the thread. The greater the length of the ring thread and the greater the thickness of the thread, the lower the vertical density. The height of the loop row can be determined by the following formula:

$$B=0,3L-2,5F+0,17$$

or B can be determined from the density ratio coefficient:

$$C = \frac{B}{A}$$

$$B = AC$$

It is recommended to take the density ratio coefficient for underwear products in the amount of 1.15÷1.20, and for outerwear in the amount of 1.05÷1.10. Coefficient S can be increased to 1.3 to obtain knitted fabrics with low surface density. [6-8]

Stretchability. High elasticity of Interlok fabric is one of its characteristic features and properties. Taking into account the high elasticity of the interlock, it is used in the manufacture of inner, upper and glove products. [9-14].

Results. Samples were taken from Z spun cotton and cotton-nitron interlock knitted fabrics. Samples differ from each other by the type of used raw materials. As raw materials, spun cotton yarn with a linear density of 20 tex, spun cotton-nitron yarn with a linear density of 20 tex (85/15) and spun cotton-nitron yarn with a linear density of 20 tex (90/10) were used.

In obtaining the I-variant of Interlock fabric, spun cotton yarn with a linear density of 20 tex per 30 systems, spun cotton-nitron (85/15) yarn with a linear density of 20 tex per 30 systems was used.

In the production of the II variant, 1 system of spun cotton yarn with a linear density of 20 tex, 1 system of 20 tex of spun cotton-nitron (85/15) yarn was used.

Next, variant III was used to obtain a knit fabric with a spun cotton-nitron (90/10) yarn with a linear density of 20 tex. The technological parameters and physical-mechanical properties of the obtained samples were determined and presented in Table 1.

Table 1

Technological parameters and physic-mechanical properties of interlock knitted fabric knitted from spun cotton-nitron yarn

Indicators		Variants 1	2	3
Types of threads, linear density		30 sys. cotton thread 30 sys.c/n thread (85/15)	1 sys. cotton thread 1 sys. c/n (85/15)	c/n thread (90/10) 20tex
Surface Density (gr/m^2)		185.4	1197.4	190.7
Fabric thickness (mm)		0.7	0.75	0.8
Bulk density (mg/sm^2)		264.8	260.9	238.4
Air permeability (sm^3/sm^2·sec)		174.5	139.9	155.2
Abrasion resistance, thousand/rotation		10.0	11.0	6.3
Tensile strength, N	height	340.8	326.4	315.7
	width	199.9	95.5	154.8
Stretching to break (%)	height	13.9	13.5	15.5
	width	47.9	48.0	55.0
Irreversible deformation (%)	height	30.0	25.0	36.0
	width	26.7	22.7	24.0
	height	70.0	75.0	64.0

Reverse deformation,(%)	width	73.3	77.3	76.0
Shrinkage , (%)	height	15.0	12.5	9.0
	width	4.5	7.5	5.0

Using the results in the table, the change of the raw material of the samples and the change of the technological parameters and physic-mechanical properties of the tissue in relation to the ratio, the analysis was made by comparing the samples. From the changes in the surface density of interlock fabrics, it was found that the type of raw material used in the production of knitwear affects the ratio of knitwear stitch from the same raw material. I-variant stitch with the addition of cotton yarn spun in 30 systems and cotton-nitron yarn spun in the next 30 systems had the lowest surface density, its surface density is 185.4 g/m^2.

Discussions. Using the same raw material, the surface density of variant II obtained using only 1 system spun cotton-nitron and spun cotton threads is the highest and is 197.4 g/m2. The reason for this is that the rapport of this variant has increased the density of the knitting and the surface density is higher. It was found that the surface density of variant III, stitch from spun cotton-nitron (90/10) yarn, is 2.8% higher than that of variant I, and 3.5% less than that of variant II (Fig. 2).

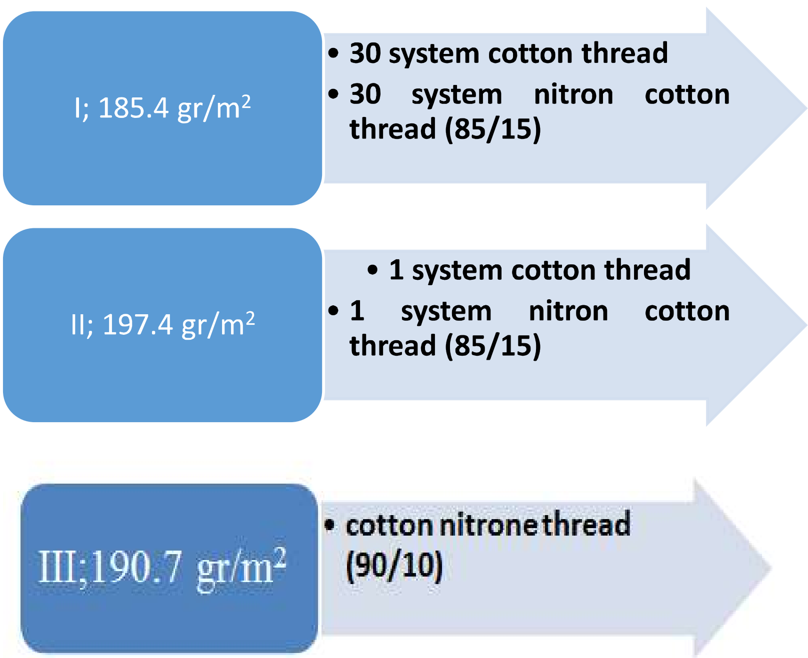

Figure 2. Interlock surface density

The thickness of interlock knitting is higher in III-variant with a higher amount of spun cotton thread than other variants, it is 12.5% higher than I-variant and 6.25% higher than II-variant.

The indicator that provides information on the consumption of raw materials in the production of knitted fabrics is the knitted bulk density. It was found that the volume density of the III -variant of the interlock knitwear obtained from the spun cotton-nitron thread is lower than the other variants, it is 11.1% lower than the I-variant, and 9.4% lower than the II-variant. So, it was determined that the production technology of the III-variant of the interlock fabric, obtained from the spun cotton-nitron thread, is the most resource-efficient (Fig. 3).

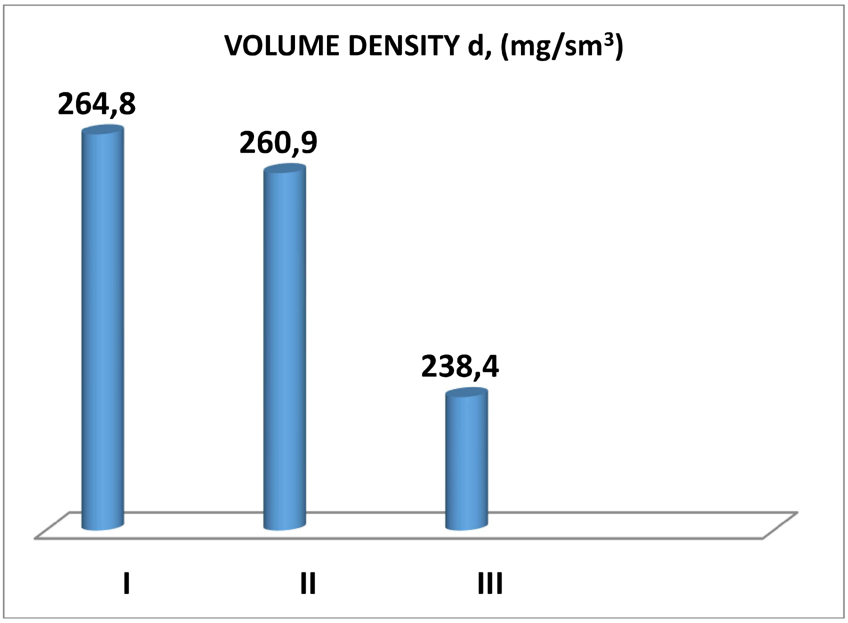

Figure 3. Change in volume density of interlock knitted fabrics

The analysis of the air permeability of the studied knitted samples showed that the knitted fabric made of Rapporti 1 system interstitch cotton yarn and spun cotton-nitron yarn (variant II) has the lowest air permeability, which means that it has the highest heat retention properties. It was found that the air permeability of this variant is 24.7% lower than that of variant I, and 10.9% less than that of variant III (Fig. 4).

The analysis of the change of the friction resistance of the studied interlock knitted samples shows that the friction resistance of the III variant obtained from spun cotton-nitron (90/10) yarn is lower compared to other variants, while in rapporti it is obtained from cotton and cotton-nitron yarns spun with 1 system interlacing and 30 systems interlacing. The abrasion resistance of variants I and II was higher (Fig. 5).

Figure 4. Abrasion resistance of interlock knitwear

The tensile strength of the interlock knitted fabric was determined to be less than the length and width. Variant I is the variant with the highest stiffness in terms of length and width of the knitted fabric.

It was found that the tensile strength of knitted samples containing spun cotton

yarn and spun cotton-nitron yarn was higher than that of samples obtained only from cotton-nitron yarn (Fig. 6).

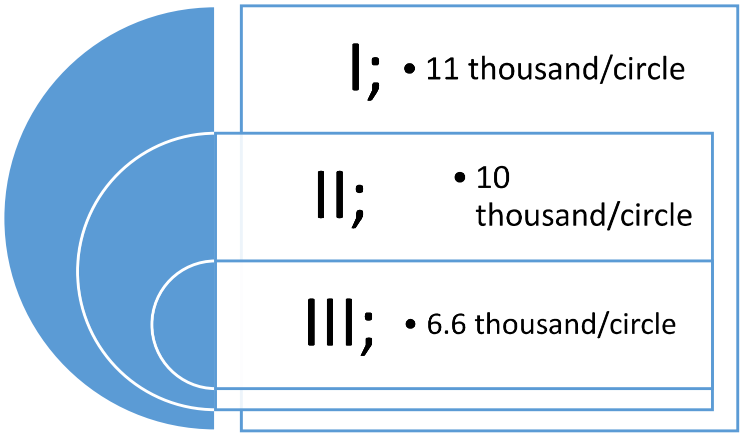

Figure 5. Abrasion resistance of interlock knitwear

Reversible and irreversible deformation changes of experimental interlock knitted samples depend on the composition and ratio of the knitted fabric. The elastic deformation of the samples obtained from the spun cotton-nitron yarn was analyzed.

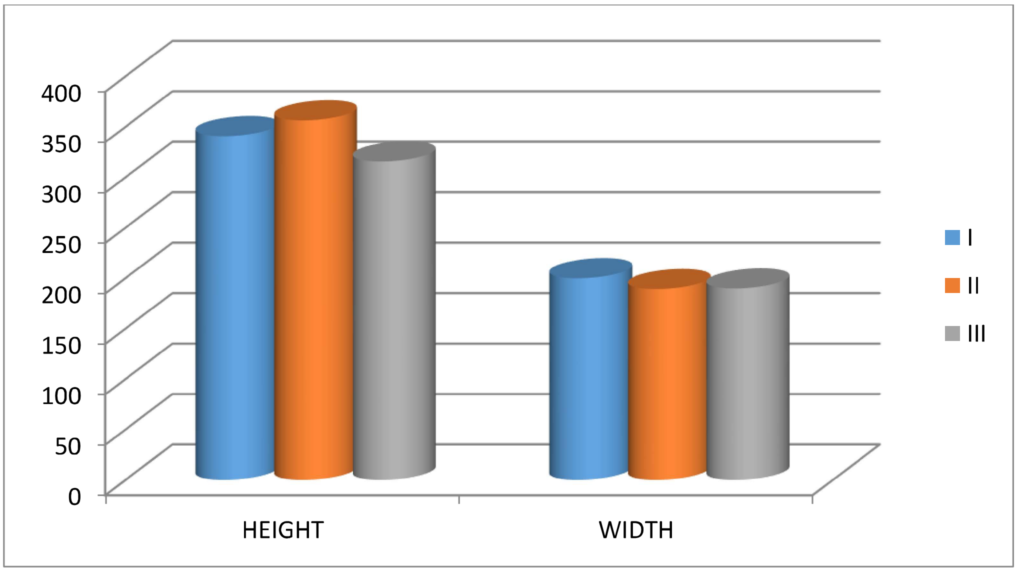

Figure 6. Histogram of change in tensile strength of interlock knitted fabric

1 row of knitted cotton yarn spun from 1 row of spun cotton-nitron (85/15) yarn. Return deformation of variant II. Cotton yarn spun in 30 system, stitch from cotton-nitron (85/15) yarn spun in 30 system. 7%, 5.2% in width, 14.7% in length, 1.68% in width compared to the III-variant stitch from spun cotton-nitron (90/10) yarn (Fig. 7).

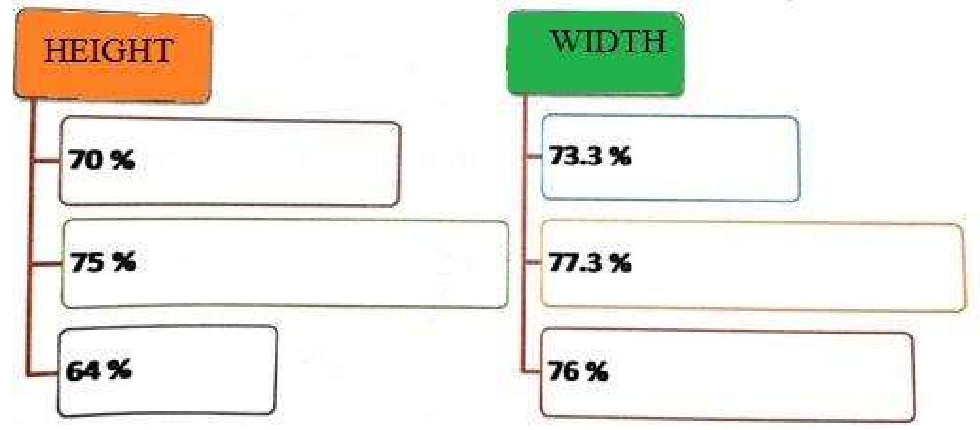

Figure 7. Reverse deformation change of interlock knitted fabric

Conclusion. The analysis of the penetration properties of knitwear revealed that the penetration of knitted samples obtained from spun cotton-nitron yarn is less than the penetration of knitted samples obtained from spun cotton yarn. [15-20].

The permeability of interlock knitting samples is the least in variant III, which is stitch from spun cotton-nitron yarn (90/10), its permeability is 66.6% less in length compared to variant I, 38.9% less in comparison to variant II, and in width I-10% more compared to variant II, 50% less compared to variant II.

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STUDY OF TECHNOLOGICAL PARAMETERS AND PHYSICAL-MECHANICAL PROPERTIES OF RIB FABRIC KNITTED FROM SPINNING COTTON-NITRON YARN

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Abstract:

Objective. For the purpose of effective use of local cotton-nitron yarn in the scientific work was conducted on the technological indicators and physical mechanical properties of rib stitch fabric. The purpose of research is develop and recommend the new technology of production of rib knitted fabric with high heat and shape retention properties by using mixed cotton-nitron yarn.

Method. Theoretical analysis and synthesis methods, the research of the knitting process was used, and experimental researches in the production conditions by Hanma (China) circular knitting machine were carried.

Results. A positive result of the properties of the fabric was achieved by the creation of the technology of knitting rib stitch fabric using cotton-nitron yarn.

Conclusion. Experimental samples of rib knitted fabrics obtained from spun cotton and cotton-nitron yarns were taken and their technological indicators and physical-mechanical properties were analyzed.

Keywords: knitting, cotton-nitron, rib, air permeability, abrasion, rupture, deformation.

Introduction. The range of products made from a mixture of natural and chemical fibers is systematically expanding in our country and abroad. This is due to the following reasons:

- due to the shortage of natural fibers, the need to increase the production of chemical fibers and expand their fields of application;

- purposeful creation of the necessary properties in the products - properties of shape retention, friction resistance properties;

- the need to replace natural fibers with high consumer properties with chemical fibers and their mixtures in the field of technical application.

Methods. For the textile industry of the Republic of Uzbekistan, it is an urgent issue to develop a complex technology for processing polyacrylonitrile nitrone in pure form and without mixing it with cotton fiber. This scientific work is based on the need to expand the field of application of synthetic fiber local raw material - nitron fiber. High heat storage properties, the ability to control the physico-mechanical properties of nitron fiber during its formation, as well as its light resistance serve as the basis for obtaining mixed fiber fabrics with new properties. If necessary, they can replace fabrics (lavsan) made from a mixture of cotton and polyester fibers brought to the Republic from abroad.

Chemical fibers have different haze colors, penetration, twistability, different geometric parameters, dyeing, luster and strength properties. The influence directed at the structure of polymer chains allows obtaining special properties of yarns. Resistant to various chemical effects, non-flammable and anti-bacterial, as well as high-modulus bicomponent, core and other yarns are widely used. For example, more than 400 types of textured polyester threads are used in the world, and their differences in color are an exception. High tenacity (high modulus) yarns have a wide range of potential, including metal, glass, carbon, arimide, and liquid crystalline polyester polyolefin yarns with long molecular chains.

The use of partially oriented fibers and yarns is growing, which allows to improve the properties of fabrics: high elasticity, resistance to abrasion, toughness, high penetration (more than 50%) during heat treatment, which allows to give high shape retention properties. Completely new materials and fabrics are being created on the basis of chemical fibers and threads. Textile materials are used in the field of nature protection (geotextile), radiolocation and communication, medicine, agriculture. Geotextile allows solving many important problems. Non-knitted fabrics, knitted and knitwear provide performance of mechanical (separation, protection, reinforcement, leveling along the surface, formation of barriers, reinforcement, adsorption), hydraulic (drainage, filtering), radiotechnical tasks. Composite materials are emerging.

The main types of chemical fibers used in the cotton thread and knitted production industry are ordinary viscose and polyester fibers.

Polyester fibers have a low price and are universal in terms of use. These fibers are most commonly used in blends with cotton fibers, although pure cotton fibers are used to blend yarns with cotton fibers to increase the softness of fabrics. This is achieved in two ways: creating staple fibers of different lengths and improving their sorption properties.

Many foreign scientists have been engaged in making textile products by preparing yarn spun from a mixture of natural and chemical fibers [1-8].

It is known that the spun cotton thread is used to make inner knitwear and hosiery products, and when outer knitwear products are produced, the knitwear has high hygienic properties and low shape retention properties. For this reason, in this work, parameters and physical-mechanical properties of fabrics that can be used in the production of outer knitted products using spun cotton-nitron yarn mixed with nitron and cotton fibers were studied.

In production conditions, 4 types of rib stitch fabric were knitted on the PAILUNG circular knitting machine. In the production of rib stitch knitted samples, spun cotton yarn with a linear density of 20 tex, spun cotton-nitron (85/15) yarn with a linear density of 20 tex, and lycra yarn were used. The difference between the samples is in the raw materials used in their development.

To obtain the I-variant of the rib stitch fabric, the spun cotton-nitron (85/15) yarn with a linear density of 20 tex and the lycra yarn were used.

To obtain the II-variant of the rib stitch fabric, a spun cotton-nitron (85/15) thread with a linear density of 20 tex was used.

Option III was made using lycra yarn and spun cotton yarn with linear density of 20 tex.

A spun cotton thread with a linear density of 20 tex was used to obtain the IV-variant rib stitch fabric.

Results. Technological parameters and physic-mechanical properties of the obtained rib stitchknitted samples were analyzed experimentally in the "CENTEX UZ" laboratory and the results are shown in Table 1.

According to the results in the table, technological parameters and physic-mechanical properties of knitwear are

changed depending on the type of raw material.

The surface density of the rib fabrics were higher in the samples made with lycra. The surface density of the 1st variant knitted by adding lycra to the cotton-nitron yarn is 25.7% higher than the surface density of the second variant knitted from the cotton-nitron yarn. The surface density of the III-variant knitted fabric by adding lycra to the spun cotton yarn is 25.2% higher than the surface density of the IV-rib stitch fabric knitted from the cotton yarn.

If we compare the surface density of the rib stitch fabric knitted from cotton yarn with the same linear density to the rib fabric knitted from cotton-nitron yarn, the surface density of cotton-nitron knitted fabric is 5.6% less than the surface density of cotton-containing rib stitch fabric.

Table1

Indicators		Variants 1	2	3	4
Types of threads, linear density		Cotton-nitron yarn (85/15) 20 tex +lycra	Cotton-nitron yarn (85/15) 20 tex	Cotton thread 20 tex+lycra	Cotton thread
Surface Density (gr/m^2)		193.7	154.1	204.3	163.2
Fabric thickness (mm)		0.7	0.55	0.8	0.6
Bulk density (mg/sm^3)		276.7	280.2	255.4	272
Air permeability (sм^3/sм^2·seк)		162.2	211.9	141.1	211.9
Abrasion resistance, thousand/rotation		22.5	20.0	24.0	18.1
Tensile strength, N	Height	290.6	322.5	394.4	340.8
	Width	124.0	95.5	154.8	94.5
Stretching to break (%)	Height	16.4	8.9	12.96	7.4
	Width	121.0	98.9	102.7	79.3
Irreversible deformation (%)	Height	10.0	26.3	23.6	26.7
	Width	12.3	26.1	14.6	17.1
Reverse deformation, (%)	Height	90.0	73.7	76.4	73.3
	Width	87.7	73.9	85.4	82.9
Shrinkage, (%)	Height	14.0	12.5	16.5	12.0
	Width	4.0	1.5	2.0	4.0

The analysis of the thickness of the knitted fabric showed that the options knitted from the spun cotton thread are thicker. The thickness of knitted samples with lycra thread will be greater than the thickness of non-lycra options. Then the thickness of the I-variant was 27.3% greater than the thickness of the I-variant, and the thickness of the II-variant was 33.3% greater than the thickness of the IV variant.

Discussions. The indicator that can fully show the consumption of raw materials of knitting is the bulk density. This indicator shows the consumption of raw materials in the production of knitwear, taking into account not only the surface of the knitted fabric, but also the thickness.

In the obtained rib knitted samples, the change in thickness changed more intensively than the change in surface density. As a result, variant III with the highest thickness has the lowest bulk density, and it was determined that its bulk density is 7.7% less than variant 1, 9.7%

less than variant II, and 6.5% less than variant IV.

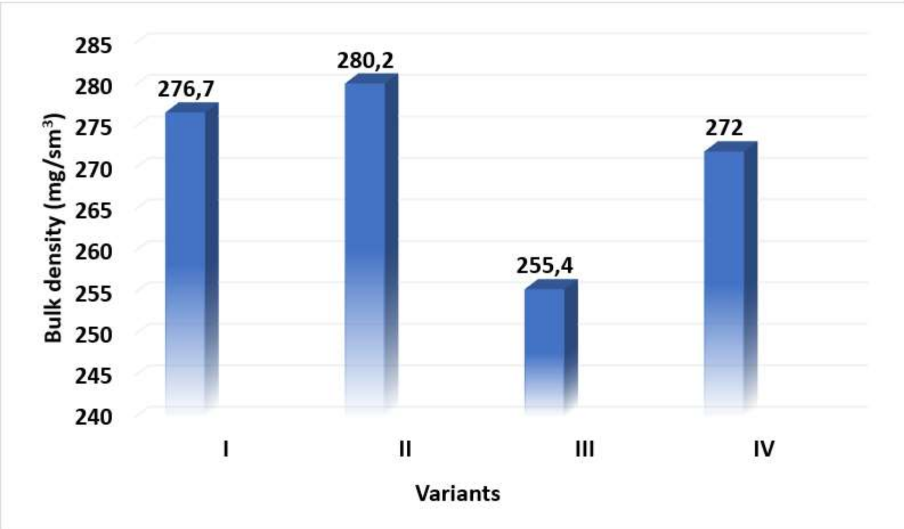

Figure 1. Change in volume density of rib stitch knitted fabrics

A feature of special importance for outer knitwear is the moisture retention property of knitwear. The air permeability of the knitted samples under study is lower than the knitted samples with lycra, which means that their heat retention properties are higher. The air permeability of the samples obtained from spun cotton-nitron yarn decreases by 6.5% when lycra yarn is knitted into it, and by 6.6% for knitted samples obtained from spun cotton yarn (Fig. 2).

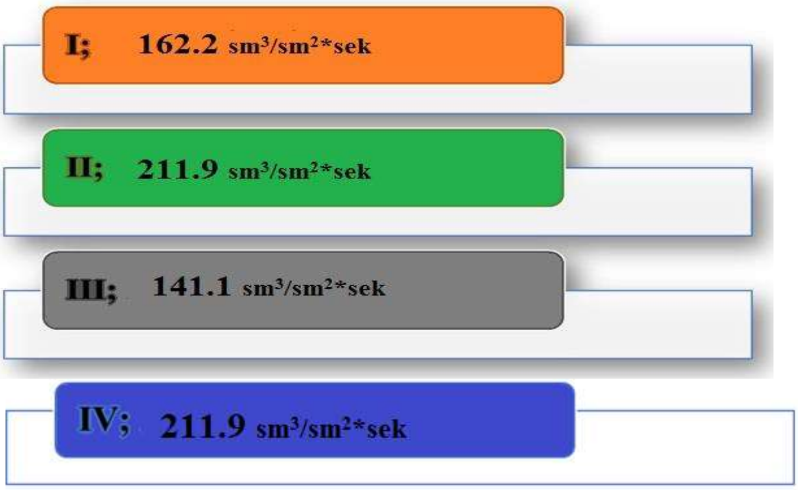

Figure 2. Change in air permeability of rib stitch knitted fabrics

The strength of the knitted fabric is determined by its abrasion resistance and breaking strength. The analysis of the change of abrasion resistance of the knitted fabric samples under study shows that the abrasion resistance of the IV variant obtained from the spun cotton thread is lower than the other variants, but the abrasion resistance of the III variant, which consists of cotton yarn and lycra yarn, is the highest. It should be noted that the abrasion resistance of rib stitch fabric obtained from cotton thread (option IV) is significantly different from the abrasion

resistance of knitwear knitted by adding lycra to spun cotton thread (III option), the difference is 32.6%, compared to the cotton-nitron thread itself (II -variant) and the abrasion resistance of the rib stitch knitted fabric knitted by adding lycra yarn to spun cotton-nitron yarn (I-variant) differs by 12.5%.

One of the most important features of knitted products is shape retention. The shape-keeping feature of knitwear is characterized by its stretchability, irreversible deformation and permeability.

The experiment leads to the conclusion that the change of irreversible deformation of rib stitch knitted samples when adding lycra to the composition of the knitted fabric leads to an increase in the percentage of its reversible deformation. At the same time, it was found that the return deformation of the samples obtained from the cotton yarn is less than the return deformation of the knitted samples obtained from the cotton-nitron yarn.

When adding lycra yarn to the composition of the knitted fabric, its return deformation increased by 22.1% in length and 18.7% in width for knitted fabric made from cotton-nitron yarn, and by 4.2% in length and width for knitted fabric made from cotton yarn increased by 3% (Figure 3).

Figure 3. Return deformation of rib stitch knitted fabric

Conclusion. Analysis of the penetration properties of knitwear shows that the penetration of knitted samples obtained from cotton-nitron yarn is less than the penetration of knitted samples obtained from spun cotton yarn.

From the analysis of the technological and physical-mechanical properties of rib stitch knitted fabrics obtained from different raw materials, it was found that the knitted fabric made from cotton-nitron yarn is lighter, more resistant to friction and has higher shape retention properties than the knitted fabric made from cotton yarn.

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ANALYTICAL CALCULATION OF THE DEFORMATION STATE OF THE SAW GIN SAW TEETH BENDING UNDER THE ACTION OF A LOAD

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Abstract: The article developed a mathematical model of the technological process of heat treatment of saw teeth using a laser beam and recommended a modern and highly efficient technological process for processing saw teeth using a laser beam, which allows preserving the natural quality of products. As a result of the increased strength of the saw teeth using the new laser processing technology, the service life of saw blades has increased, the cost, productivity and efficiency of the saw cylinder has increased.

Keywords: with saw, cleanliness, grinding, release, technological process, residual deformation, geometric size, layer, hardness, durability, minimum heat, polished surface, solution exposure, cooling, cycle time, load, saw. tooth, equation, slope.

Introduction. One of the most common heat treatment methods is laser etching technology. The essence of the method we have chosen for this work is that a highly concentrated energy source - a laser beam as a source of local heat treatment (hardening) has high technological and technical and economic advantages over traditional bulk or thermal and chemical-thermal processing technologies.

When considering this method from a scientific point of view, laser equipment of surfaces eliminates the shortcomings of volumetric thermal equipment, chemical-thermal treatment and, at the same time, opens up new potential technological possibilities when equipping the surface layer of machine parts and mechanisms [1].

The current level of development of laser technology and technology considers the laser as a convenient, economical and reliable tool for thermal grinding of the surface layer of machine parts of a wide range.

The impact of a laser beam on the surface of steels leads to a comprehensive improvement in the physicochemical and mechanical properties of the surface layer, which manifests itself in a high dispersion and isotropy of the structure of the surface layer, increased microhardness, heat resistance, corrosion resistance, and abrasion resistance [2].

The advantages of laser resurfacing can be classified into technological, energy, operational and environmental types.

- The method of laser thermal clarification (hardening) has a number of technological advantages over traditional methods of heat treatment, which are manifested in the following properties [3]:
- it is not required to carry out the technological process of extracting after laser resurfacing;
- residual deformations will be minimal or absent at all;
- during laser polishing, the geometric dimensions of the part are kept within acceptable limits;
- the hardness of the exfoliating layer increases;
- increased resistance to abrasion;
- - the processed detail demands the minimum heating;
- locally affects the deposited surface;
- coolants are not required;
- easy to automate and robotize;
- the duration of the thermal annealing cycle is reduced.

Main part. An analysis of the operational state of the saw-demon teeth shows that the main criterion for their performance is the eroding strength. In this case, the main attention is paid to abrasive

corrosion and mechanical corrosion in the form of plastic crushing [3].

When the saw teeth are connected to the raw roller during dismantling, a continuous load occurs on the border of their front surface from the end to the base. Intensive erosion of the teeth of the demon saw occurs during the decay of low-grade cotton raw materials containing, in addition to impurities, hard mineral particles of abrasive properties (corundum, granite, limestone), corroding and removing micro-dimensions at the junction of the surface layers of the tooth. With this interaction, the geometric parameters of the tooth change: its height decreases, an edible chamfer forms at the back, the tip of the tooth and the edges of the lateral surface become impenetrable (rounded). Such changes in the profile of the teeth decrease their gripping ability, which of course reduces the fecundity of the molt and increases the hairiness of the molt.

Crushing the plastic at the ends of the saw teeth prevents them from penetrating the raw bead and reduces the amount of fibers that can be plucked from the seeds.

Solution. The transformation of the tip of the tooth and its bending in the direction of rotation of the saw chisel can lead to a decrease in cutting efficiency at a high level due to a decrease in the technological gap between the teeth. The loss of such performance by a sawtooth tooth can occur due to insufficient rigidity of sawtooth materials, the presence of random solid foreign objects in cotton raw materials, as well as when processing low-grade dense and wet cotton materials.

Figure 1. Graph of tooth profile changes due to plastic bending and crushing

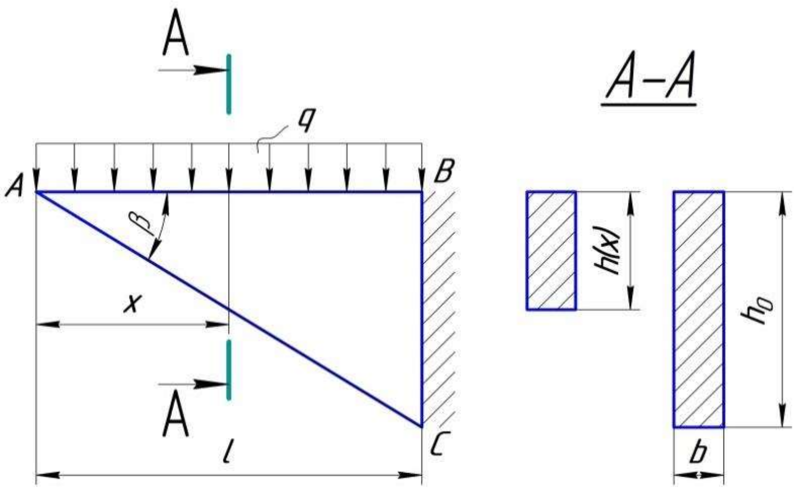

Figure 2. Cantilever hammer with length l, constant width b and variable height h(x), loaded with a uniformly distributed load q;

The initial inclination of the toothed end or its top can be considered as the bending of the cantilever hammer under the action of a variable shear force at the junction with the unfinished bead (Fig. 1). Although the nature of the load on the front surface of the tooth is uneven, in the first approximation, we assume that the tooth is loaded with a flat distributed load q (Fig. 2).

Therefore, the analytical assessment of the tooth bending under the influence of a technological load according to the given geometric parameters is of pronounced scientific and practical interest, since it allows you to calculate the amount of bending of the tooth tip (the tip of the cantilever hammer), determine the degree of influence of the tooth parameters and justify their values, which can subsequently be changed for increasing their curvature and resistance to plastic crushing.

The saw gin tooth b of constant width, h(x) of variable height VS trimming is taken in the form of a reinforced AV cantilever hammer (Fig. 2). The uniformly distributed load q is equal to the ratio of the total force acting on the apex VAS of the wedge to the length AV of the front surface of the tooth.

M0 is the bending moment, Let W0 be the modulus of the part VS to which the hammer is attached. The condition of equal resistance (equal strength) of this hammer to bending can be used by the following expression [4]:

$$\sigma_{max} = [\sigma]$$

$$\sigma_{max} = \frac{M_0}{W_0} \quad (1)$$

ere: [σ] – allowable normal bending stress, MPa.

If we take into account M (x), W (x) - respectively, the bending moment and the shear resistance moment at a distance x from the end of the hammer, then (1) Determine the expressions for the quantities included in the equation:

$$M(x) = \frac{qx^2}{2};\ W(x) = \frac{b[h(x)]}{6}$$

$$M_0 = \frac{ql^2}{2};\ W_0 = \frac{bh_0^2}{6}$$

we get

$$\frac{M(x)}{W(x)} = \frac{qx^2}{2} \cdot \frac{6}{b[h(x)]} = \frac{ql^2}{2} \cdot \frac{6}{bh_0^2} \quad (2)$$

From proportional ratio

$$\frac{h_0}{l} = \frac{h(x)}{x}$$

Output h(x)=h_0·x/l, or 〖h〗_0=l_0·tgβ, taking into account the law of cutting height change, we get:

$$h(x) = h_0 \cdot \left(\frac{x}{h_0}\right) \cdot tg\beta, \quad (3)$$

In this case, the shear moment of inertia mn depends on the moment of inertia J0:

$$J(x) = J_0 \left(\frac{x}{h_0} \cdot tg\beta\right)^3, \quad (4)$$

from the hammer equation with a bent axis [3]

$$EJ(x) \cdot \frac{d^2y}{dx^2} = -\frac{qx^2}{2} \quad (5)$$

(4) given the expression,

$$EJ_0 \cdot \left(\frac{x}{h_0} \cdot tg\beta\right)^3 \cdot \frac{d^2y}{dx^2} = -\frac{qx^2}{2},\ EJ_0 \cdot y'' = -\frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3 \cdot \frac{1}{x} \quad (6)$$

(6) integrating the differential equation on x, we obtain the following expression

$$EJ_0 \cdot \frac{dy}{dx} = -\frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3 lnx + C_1,$$

here: S1 integration constant x=l=ho/tgβ, y´=0 is found from the initial condition when:

$$C_1 = \frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3 \cdot ln\left(\frac{h_0}{tg\beta}\right)$$

$$EJ_0\frac{dy}{dx} = -\frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3 \cdot lnx + \frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3 \cdot ln\left(\frac{h_0}{tg\beta}\right). \qquad (7)$$

(7) if we integrate the differential equation for the second time, it will look like this [5]:

$$EJ_0 \cdot y = -\frac{q}{2}(x \cdot lnx + \frac{q}{2}) \cdot \left(\frac{h_0}{t\beta}\right)^3 \cdot x + \frac{q}{2} \cdot \left(\frac{h_0}{tg\beta}\right)^3 \cdot ln\left(\frac{h_0}{tg\beta}\right) \cdot x + C_2.$$

S2 constant if x=l=ho/tgβ, from the initial condition we determine y=0:

$$C_2 = -\frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^4.$$

So the bending equation will look like this.

$$EJ_0 \cdot y = -\frac{q}{2}\left(\frac{h_0}{tg\beta}\right)^3\left(x\ lnx - x - x\ ln\left(\frac{h_0}{tg\beta}\right) + \left(\frac{h_0}{tg\beta}\right)\right) \qquad (8)$$

The greatest bending of the considered hammer will be at a shift x = 0. To take this condition into account, it is necessary to reformulate the last product of expression (8):

$$x\ lnx - x\ ln\left(\frac{h_0}{tg\beta}\right) = x\ ln[\frac{x}{h_0/tg\beta}].$$

If x → 0, then the right side of the last equation tends to zero, that is:

$$\lim_{x\to 0}[x\cdot \ln[x/(h_0/tg\beta)]]=0.$$

Thus, the largest value of beam bending is:

$$y_{max}=-\frac{q}{2EJ_0}\left(h_0/tg\beta\right)^4. \qquad (9)$$

We evaluate the bending of the genie saw tooth under technological loads. Data for calculation: Ye = 2 105 N/mm2 – toughness modulus of steel; b = 0.95 mm is the thickness of the teeth; h0 = 1.5 mm - measurement of the height of the base of the tooth; β = 200 – tooth sharpening angle; $J_0=(bh_0^2)/12$, mm4 - moment of inertia relative to the axis of the cutting edge corresponding to the base of the tooth; q=P/l – uniformly distributed load, N/mm; R is the total force acting on the tooth up to 6-10 N, l, mm is the length of the front surface of the tooth, equal to 3 mm.

Conclusion. The greatest bending of the tip of the genie saw teeth, calculated from theoretical calculations by equation (9), is 0.008 mm, which is more than 5 times the bending under the action of the total force applied to the end of the tooth. Thus, the technological load on the capture of free fibers by the front surface of the tooth leads to a slight bend in the direction opposite to the rotation of the saw during piercing.

The bending of the tooth tip can be caused by the intense impact of a dense raw bead on the back surface of the tooth, which leads to a greater inclination of the profile towards the direction of rotation. In this case, the front surface of the tooth is connected to the free fiber only when it enters the raw roller and breaks the fibers. Then the back surface actively interacts with the raw bead along the entire arc of engagement and is subjected to a long-term force in relation to the front surface of the tooth [6].

Changing the plastic shape of the toothed tip in the direction of rotation of the sawtooth cylinder can also cause a concentration of specific load in the erosion zone created by the raw roller on the back surface of the tooth.

The slope of the tooth profile can also be caused by its insufficient rigidity or uneven distribution in thickness due to

decarburization of the surface layer during heat treatment of the surface layer of the structure.

Thus, the deflection of a variable-section cantilever gin beam saw tooth under the action of technological loads is estimated as the largest deviation in accordance with the axis equation. It is based on the fact that it is possible to avoid large deviations of the tooth profile, which reduce the efficiency of dismantling due to the introduction of mechanical reinforcement technology, which leads to deformation reinforcement (compaction) of the surface layer and the formation of residual compressive forces in it.

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UDK 687.45

ANALYSIS OF HEADWEAR AND BERET IN FASHION

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Abstract:

Objective. the purpose of the research is to improve the quality of the beret based on the analysis of women's headdresses, to make effective use of natural and seasonal fabrics.

Methods. in this article, the history of creation and development of European, American and Asian headdresses, as well as the changes and losses that occurred during this interval, were studied. Various types of headwear were studied, and their fabrics were tested and analyzed for their physical and mechanical properties. The design-project construction documents for the production of women's headwear from the optimal options of gauzes with high air and water permeability characteristics of knitwear, cloaks, artificial leather, seasonal fabrics are proposed.

Results. Weather conditions in the territory of Uzbekistan were analyzed and hair, scalp, skin diseases and symptoms caused by adverse weather were studied by medicine, taking into account hot and cold temperatures and negative health effects for women. It is planned to launch the production of comfortable and seasonal headgear that does not show secrets.

Conclusion. it is applied to the production of beret in a new design using knitwear, plaid, artificial leather, natural and seasonal fabrics.

Keywords: history of headgear, human health, hair and scalp diseases, seasonal indicators, different types of knitwear, cloak, membrane, leather, artificial leather fabrics, wet elasticity, air permeability, thickness increase indicators, tensile strength, ergonomic, aesthetic, hygroscopicity, artificial, mechanical properties, construction, technology.

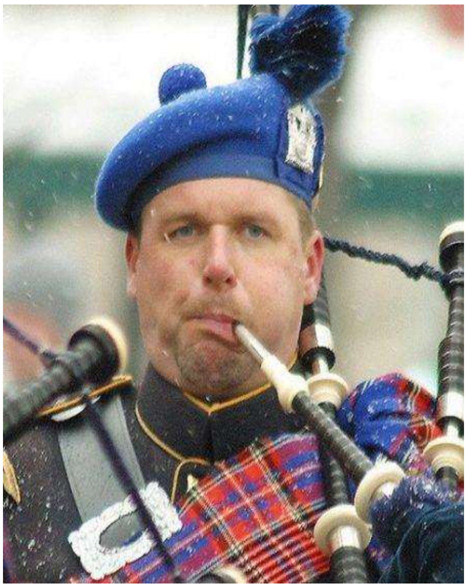
Introduction. In the years of independence, light industry took a strong place in the macro-economic complex of our country. Extensive involvement of foreign investments and modern technologies, modernization of production, technical and technological updating, effective projects for the development of small business and private entrepreneurship ensure the achievement of high indicators in the production sector [1].

Methods. A decision was made on measures to promote the further development of light industry and the production of finished products, and the target parameters for 2020-2025 for the production and export of textile, sewing-knitting, leather-footwear and fur products that meet market requirements based on the processing of raw materials confirmed [2].

Due to the temperate climate of Central Asia and Uzbekistan, summer is hot and winter is cold. In such conditions, comfortable and modern clothes are of great importance. For example, a beret is a women's headdress that never goes out of style.

There are several versions of this headwear look. The first version mentions the prototype of the beret of our time - the Celtic headdress. It is preserved in well-formed Scottish dress, and is called "tam-o-shenters." A wide woolen cloth with a small ball in the middle is expressed in the form of a beret (fig.1.pictures 1-2).

picture 1



picture 2

Fig.1.A wide woolen cloth with a small ball in the middle is expressed in the form of a beret

Initially, all such "tem-o-senters" were available only in blue colors. During the First World War, these hats entered the uniform of the Scottish army. According to the second version, the history of the appearance of the beret goes back to Ancient Greece. The

Romans took it from there. They were the first to decorate berets in different colors, and this became a sign of differentiation, distinguishing the rich from the poor (fig.2, pictures 3-4).


picture 3


picture 4

Fig.2. Ancient women's classy headdress

In the 15th century, this headdress became an attribute of priests and looked a little like a square hat.

At the same time, the French wore beret hats decorated with precious stones, ostrich feathers and various ornaments. This attribute of clothing was respected by almost all residents of the country.

Round berets were first observed in Spain in the 16th century. Wealthy townspeople put feathers and braids on them.

The 17th century is the age of romanticism. At this time, the beret hat was very popular among creative people. Thus, when Italian artists often painted portraits, famous people were presented in different colored hat berets.

In the 19th century, the fashion for beret hats came to Russia. They were worn only with official clothes. Only the finest materials were used in the production and they were decorated with rare precious stones. The most common bright colors were considered: red, dark red and green.

This headdress can be seen not only at fashion shows. The beret hat has become a basic item of clothing in almost all armies of the world. The Royal Tank Regiment of Great Britain was the first to use the beret in its military equipment.The beret came to the former USSR in 1936 as an attribute of the female military uniform, and since 1963, the beret has become an element of the special forces(fig.3.5-6-picture).


picture 5


picture 6

Fig.3.The beret became a basic clothing item in all armies

As we all know, the Green Berets of the US Army Special Forces are their standard headgear and are a popular choice for many military kids. But in fact, before 1961, Green Berets were also unofficial accessories. In the mid and late 1970s, red berets and green berets were designated as special accessories for the Air Force and Army Special Forces. Black Cerberyl was first used by Ranger troops [18].

In the Middle Ages, such headdresses were worn not only by artists, but also by writers. Berets are an attribute of French clothing, since the French army began to wear them in the late 20th century.

Also, at the end of the 20th century, women of the former Soviet Union began to wear headdresses. This was followed by the wide spread of the fashion attribute of clothing throughout the world. Over the years, the demand for them and the rules for choosing them have not changed. The type of headgear of the 20th century can surprise anyone now: cloche, gaucho, toque, fezca, cotelok, fedora, trilby, canoe, Tyrolean hat and others.

Today's berets are modern, comfortable and somewhat modeled. In the production of berets, they perform several tasks and meet certain requirements: they should protect a person from unfavorable climatic conditions and should not have problems related to air circulation indicators in the intermediate distance in the head [17]. A person can get several diseases due to not wearing a hat in different weather conditions. For example, snow and bitter cold in winter cause various changes in the human body.

Due to not wearing headgear, head and skin colds in winter, allergic itchy rashes, duration of chronic diseases, dust and pollen wind in spring and autumn, hair and skin damage due to reaction of precipitation with alkali on the head. Hair loss , hot summer sun rays damage the natural look of hair, cause burns of exposed skin and hair fibers, redness and darkening of the body, skin shedding or similar harmful consequences.

The product must fully meet consumer and production requirements: operational, hygienic, aesthetic, ergonomic, physical-mechanical, etc. Today, types of berets made of threads, knitted, fur, thick and elegant fabrics with constructive designs in various styles are widespread. The main thing is to develop a design based on the gender and age of consumers [9].

Hats that have gone out of fashion today are coming back into the tradition. Such a trend can be found not only on catwalks, but also on city streets. Most women between the ages of 15 and 45 prefer to wear headwear. When choosing, a headgear is chosen mainly according to the structure of the human face, it makes it more beautiful and attractive [19].

Based on the analysis of the literature on psychology, imageology and design, theoretical models of appearance, face, headgear systems were developed, it was studied that the components of these systems are included in the information supply of the headgear design method. An analysis of existing classifications of headgear, as well as different approaches to its design, was carried out [20]. The need to develop the classification of individual types of human head and face and their geometric coding models was determined. Experimentally statistically significant features that determine the choice of headgear are determined. In order to create a harmonious image of a person through headdress, it is necessary to take into account a number of individual characteristics of a person's appearance. A database for providing information to the Face system, which is part of the appearance system consisting of individual variations of human head and face types, has been developed [12]. The resulting database shows the appearance of a

person (face part) in frontal projection by forehead height, nose size and distance between eyes (eye position) and profile by forehead convexity, face angle and chin allows classification in the projection (fig.4.7-8-picture)[13,21,22].

picture 7

picture 8

Fig.4. Modern women's clothing

Taking into account the different shapes and heights of the crown, the width and diversity of the facial areas, a classification of the main hats was developed, and based on it, a matrix of variations of the main hat and berets used in the design was developed [8].

Results. There are several indicators that are important when choosing a headdress for women and applying it to production:

- in which region and in which season to use the product (organization of production based on the mentality and customs of each nation);
- in the production of any sewing products, it is necessary to pay attention to the analysis of its materials. Selection of fabric based on the season, age, body and face structure, etc. [7];
- drawing up a perfect project, paying attention to constructively important indicators;
- the selected fabric and style are modern in line with current fashion;
- production of each selection in accordance with established measurement standards [14];

In the production of products, its fabric is of great importance, and therefore the following experiments were conducted on several fabric assortments in the laboratory equipment of the "Textile" department of the Namangan Institute of Engineering and Technology.

The equipment in figure 12 is used to measure the air permeability of woven fabric, knitted fabric, non-woven fabric, filter paper and industrial filter fabric [2].

Using the YG461E fabric air permeability tester, samples of 3 different fabrics were taken 5 times and their average was calculated and information about this was given in the table (Table-1).

1. Sample-1= $\frac{1.510+1.548+1.401+1.569+1.483}{5}=1.5022$

2. Sample-2= $\frac{0.350+0.327+0.327+0.343+0.369}{5}=0.342$

3. Sample-3= $\frac{0.778+0.786+0.773+0.798+0.913}{5}=0.8096$

table 1

Air permeability of cloak fabric types	
Types of cloak fabric	Air permeability ($sm^3/sm^2/s$)
Sample-1	1.5022
Sample-2	0.342
Sample-3	0.8096

The YG141D fabric inspection device can directly measure and measure other delicate materials, such as knitted fabrics and so on. This machine is widely used in the production of cotton products, knitted products, sheets, handkerchiefs and paper. , Y141D meets ISO 5084, ISO 9073.2 and other standards.Experiment was conducted on 3 different cloak samples in the production fabric measuring device. During the work, 5 samples were taken and the average value was calculated from them (Table 2).

1. Sample-1 = $\frac{0.535+0.551+0.558+0.573+0.558}{5}=0.5586$
2. Sample-2 = $\frac{0.078+0.076+0.075+0.75+0.077}{5}=0.0762$
3. Sample-3 = $\frac{0.220+0.216+0.222+0.222+0.223}{5}=0.2206$

Table 2

The thickness of the fabric types	
Types of cloak fabric	Thickness (mm)
Sample-1	0.5586
Sample-2	0.0762
Sample-3	0.2206

YG026T is a constant rate of elongation (CRE) testing machine for tissue tensile strength and elongation. It is designed for a wide range of applications: strength test, tensile test, fracture test, welding test, constant load test, constant elongation test, etc. It is used to test threads, fabrics, clothes, non-woven fabrics, etc.

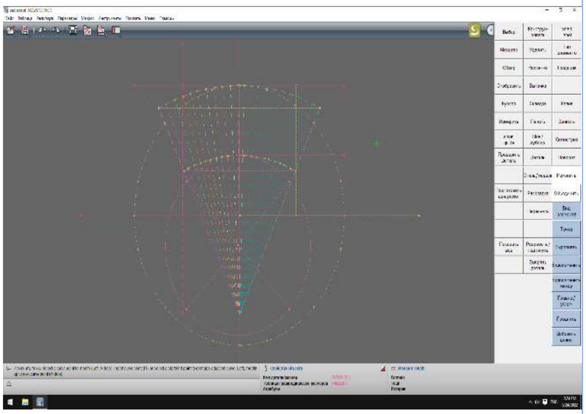
Applicable standards: ISO 13934-1-1999, ISO 13934-2-1999, ISO 9073-4-1997, ISO 13936-1-2004, ASTM D3936, GB / T3917.1, GB / T3917.2, GB / T3917. 3、GB/T3923.1 etc. 3 different samples of fabrics were tested on the YG026T device(table 3).

Table 3

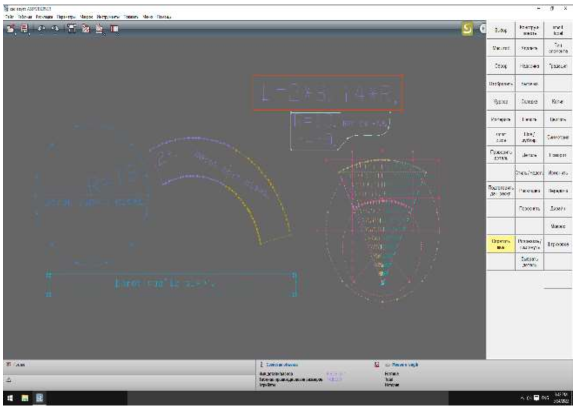
Indicators		Indicators
	1- Sample	
Strength (N)	887	436
Elongate (mm)	47.2	29.1
e-rate (%)	23.60	14.55
b-work (J)	20.5	6.9
Brk-time (s)	14.18	8.74
	2- Sample	
Strength (N)	435	434
Elongate (mm)	31.8	41.7
e-rate (%)	15.90	20.85
b-work (J)	6.9	8.0
Brk-time (s)	9.55	12.51
	3-Sample	
Strength (N)	585	771
Elongate (mm)	139.5	69.0
e-rate (%)	69.75	34.50
b-work (J)	41.9	32.7
Brk-time (s)	41.87	20.72

Discussion. These fabrics were analyzed in the laboratory of the Department of Textiles of the Namangan Institute of Engineering and Technology using special equipment. A study was conducted to determine properties such as hygroscopicity, tensile strength, and elongation at break. Based on the fabric experiments, the women's hats of the project were sewn at the "Orzu-ideal textile" men's and women's outerwear manufacturing enterprise under the IDEAL brand in Namangan, and the stitch strength, design and shape retention indicators were tested on the finished product. The parameters of the fabric and the quality parameters of sewing, determined in the experiments, coincided with each other with a high probability.

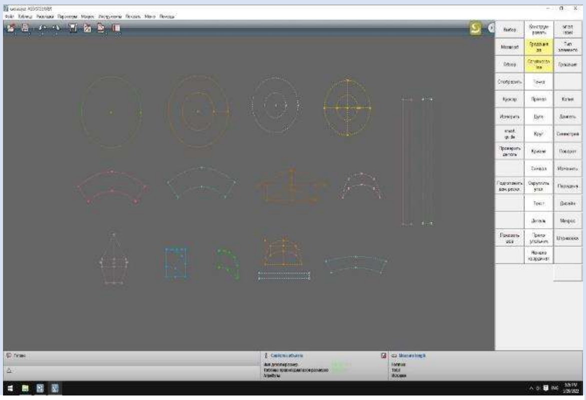
For women's headdresses, a fabric with a high content of cotton fibers is considered preferable. The reason is that in many cases, when wearing artificial or woolen, artificial leather, cloak fabric headgear, itchiness, redness, rashes can be observed on the forehead [15]. I chose knitted fabric to avoid this inconvenience and achieve success by meeting operational and aesthetic requirements. The ASSYST program [16] and mathematical formulas used for the development of a women's beret can be seen below in the sample pictures showing the manufacturing process of the product and examples of sewing technology(fig.5-6.11-13;14-20-picture) [11].



11-picture



12-picture

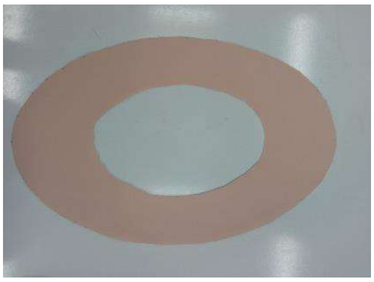


13-picture

Fig.5.The process of designing a beret headgear in the ASSYST designer-design program

14-picture

15-picture



16-picture

17-picture

18-picture

19-picture

 20-picture	**Fig.6.Technological preparation process of beret headgear**

The use of logical thinking, observation, systematic scientific research, statistical and cross-sectional analysis methods in the study of statistical data and theories related to the research process. Statistics Committee of the Republic of Uzbekistan and "Statistics Committee of the Republic of Uzbekistan" and "Statistics Committee of the Republic of Uzbekistan" as well as analyzes of foreign literature and news were studied [6].

Conclusion. In order to increase the requirements of the production of products suitable for the modern market, it is necessary to eliminate the effective way of personnel support, to update the production, to update the production, to update the production, to update the production [4].

The analysis of special literature revealed that the existing anthropometric research program does not provide any full-size typical head. To date, mass anthropometric measurements of adults have not been conducted [10]. There is no dimensional standard that takes the classification of typical women's heads and the size of the industrial design of headgear. Analytical analysis of the study of the face of the head was carried out, it was found that none of the researchers conducted an analytical study on the study of facial symmetry, its absence can affect the choice of headgear and symmetry [5,] 8]. All in all, on the basis of accurate physical-mathematical analysis, work was carried out on several constructions and technological processes, and by choosing the optimal options, the necessary experience was gained [3].

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CREATION OF A NEW MODEL OF WOMEN'S COAT

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Abstract:

Purpose. the purpose of the research is to create a new model of women's cloak based on the analysis of artificial leather materials, taking into account the demands and wishes of women.

Methods. in this article, a new model was created by studying the origin, types, and patterns of women's cloaks for the spring-autumn season. Development of design and technological documents and drawings of women's cloak using the "M. Muller i syn" methodology.

Results. multi-functional models of women's cloaks were created from artificial leather. raw materials were used.

Conclusion. in the production of women's cloaks from artificial leather materials, innovations have been introduced to the currently available models and convenience for consumers has been created.

Keywords: cloak history, artificial leather, women's cloak, kitel, skirt, construction.

Introduction. In the years of independence, light industry took a strong place in the macro-economic complex of our country. Effective projects on the wide involvement of foreign investments and modern technologies, modernization of production, technical and technological renewal, development of small business and private entrepreneurship ensure the achievement of high indicators in the field of production. [1, 2]

The origin of the cloak has a long history. At first, the cloak entered the wardrobe of men. Therefore, it is still an integral attribute of the strict image of men. At first, cloaks belonged to the strong part of humanity. But women slowly introduced cloaks into everyday life. [3]

Until the III-IV centuries, the fold was considered the main feature of Roman women's clothing. A women's tunic is similar to a man's dress. Women wore a wider and longer stola over the tunic. A cloak is worn over the table. Sometimes the cloak was covered over the tunic. Cloaks were worn by twisting them around the body using various methods, and sometimes one end of it was thrown over the head. Women also wore penulas as outerwear. Women's shoes were made of different colors of leather, decorated with embroidery or buckles, and sandals and ankle boots. [4]

Today, we can find women's cloaks in different lengths. For example, from the short length to the longest look. Modern women choose different types of cloaks according to their comfort and preferences. These are different lengths for tall, middle and small women, and every woman has a length that she is comfortable with. [5] (Figure 1)

Figure 1. Cloaks of different lengths

Currently, the assortment of cloaks is divided into the following groups:

• semi-wool yarn,
• viscose yarn,
• film coating thread,
• film coated,
• kapron thread,
• from natural and artificial leather fabrics.

In order to maintain the shape of the clothes, in the preparation of the cloak, stiffened gauzes are used in the adip, hem, collar, flap, valves, and feathers. Non-woven adhesive gauzes or glue-coated adhesive gauzes are used as adhesive gauzes. The assortment of lining fabrics consists of viscose and viscose-acetate lining fabrics, kapron lining fabrics, as well as kapron knitted linings. [6, 7]

Nowadays, in the world of fashion, we call outerwear made of light, thin and strong fabrics in the spring-autumn seasons under the general name cloak. Classic-style coats are enriched with various new designs and decorations every season.

The most popular: that's right - wide cloaks. In the spring-autumn season, we can see that people's desire for lightness and freedom is reflected in clothes. Almost all models with a light and comfortable silhouette have a wide design starting from the shoulder line. In these models, which are as bright as white paper, the experimental patterns provide a good impression, and they also give a clear shape to the models. Simplicity and comfort are combined with a new seasonal look and high taste in this light coat. If we pay attention to the color - white, indigo, all bright colors are popular this season. Main fabrics: cotton fiber, mixed linen fiber, artificial leather of various colors, etc. [8, 9]

In this scientific work, based on my topic, I want to create a new model of a modern women's cloak from artificial leather fabric. Therefore, I am carefully studying the features of artificial leather fabric.

Artificial leather has the following properties: actual, deformation, tearing, friction, moisture and washing agents, high temperature, light wear, resistance and bending resistance, paint strength, viscosity, etc. Since many types of artificial leather are related to humans, the most important aspect is that they meet hygienic requirements. It does not emit a smell, toxic substances are neutralized, it has high hygroscopic properties. It is also required that they meet the requirements of the standard. For example, the following requirements apply to artificial leather. To check the material's resistance to deformation, a weight of 50KN is placed on the sample. After receiving the weight, the sample should return to the first position. The tensile strength testing equipment stretches the material until it breaks. [10, 11]

Artificial leather is a combination of materials with satisfactory mechanical properties, form acceptance and hygienic properties, combined with a polymer film with high water permeability and abrasion resistance, which resembles natural leather. (Figure 2) Figure 2. Faux Leather.

Figure 2. Faux Leather

Outerwear made of artificial leather is designed for spring and autumn seasons, in which the weather is very changeable. Recommended types of clothing made of artificial leather (suit, jacket, cloak) are very important at this time. The reason is that the recommended types of clothing are distinguished from other artificial leather products by the fact that they are breathable, do not make the body uncomfortable in hot days, and do not catch the cold in cold days. In addition, it is possible to produce different types of shoes using artificial leather raw materials. Clothes made of artificial leather are a type of clothing that meets the aesthetic requirements of today's modern day.[13,12]

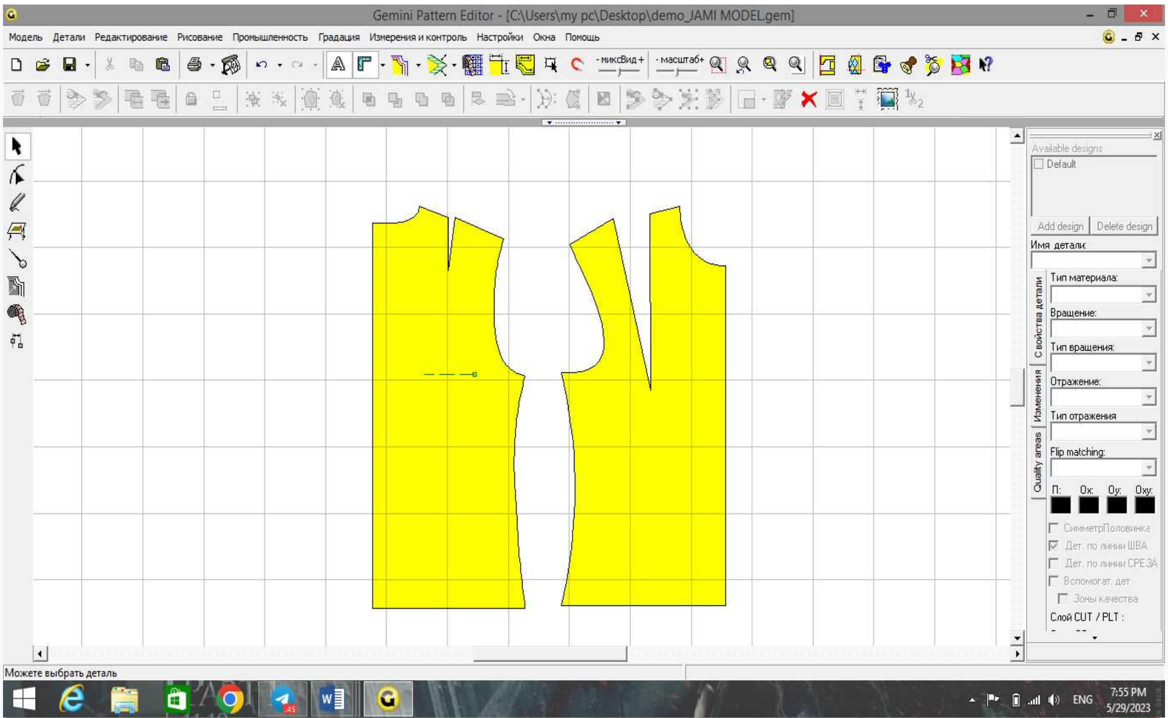
To decorate women's cloaks, embroideries of various constructions, reliefs, decorative stitches, printed lines, various decorative fabrics (leather, ribbons) and embroidery are used. Furniture (buttons, hardware, various metal elements, glue, wood, suede, etc.) is of great importance for the appearance of clothes.

The length of the dress is made according to the modern fashion direction, the hem part is made according to the technical description of the model. [14]

Many studies have been conducted on modern women's cloaks. L. Asatillayeva, M. Khoshimova published an article based on the analysis of many modern women's coat assortments, A. Toshev, M. Temirova, S. Musayev conducted scientific research on the properties of artificial leather in order to create convenience for people. [15]

In the course of scientific research, a new model of women's cloak was created after studying the demands and wishes of consumers.

Multi-functional models of women's cloaks were created from artificial leather. First, the design of the cloak for the bodice and skirt was designed in the GEMINI CAD program. [16,17] (Figure 3)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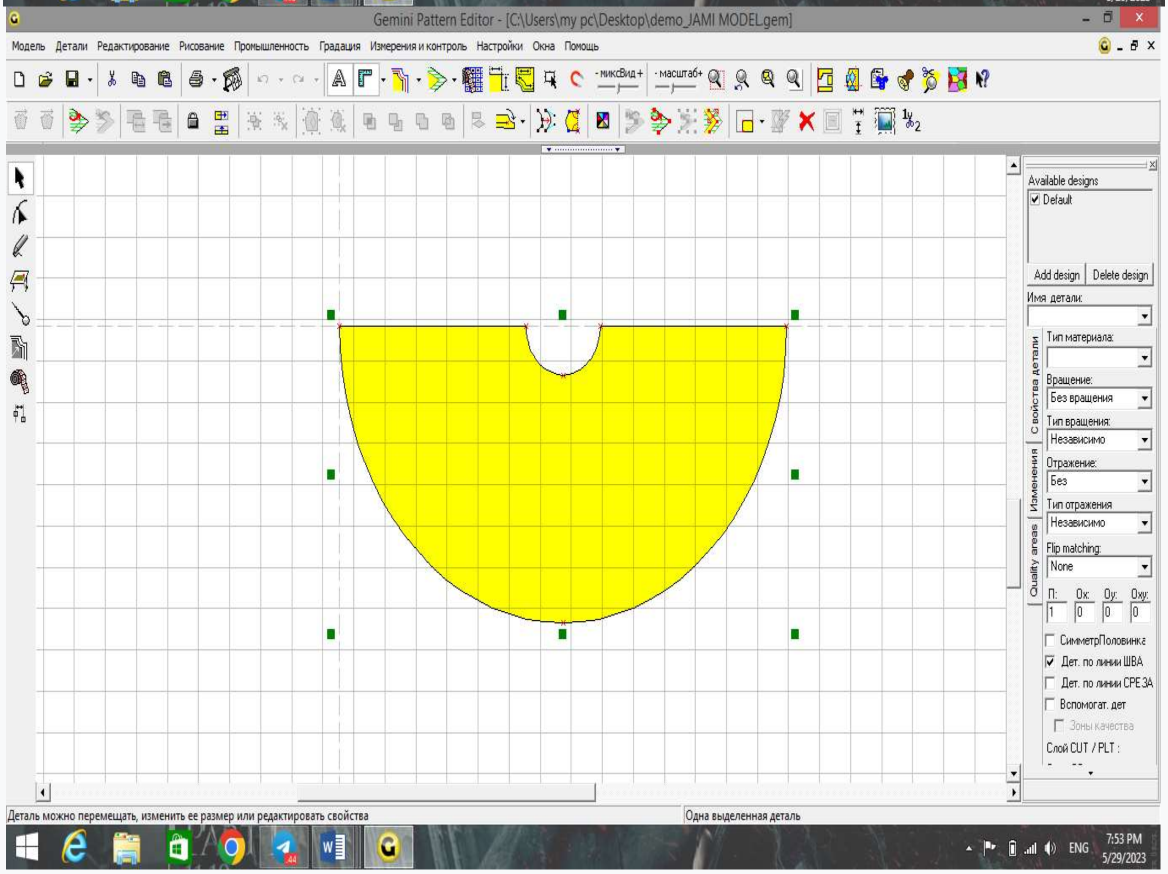
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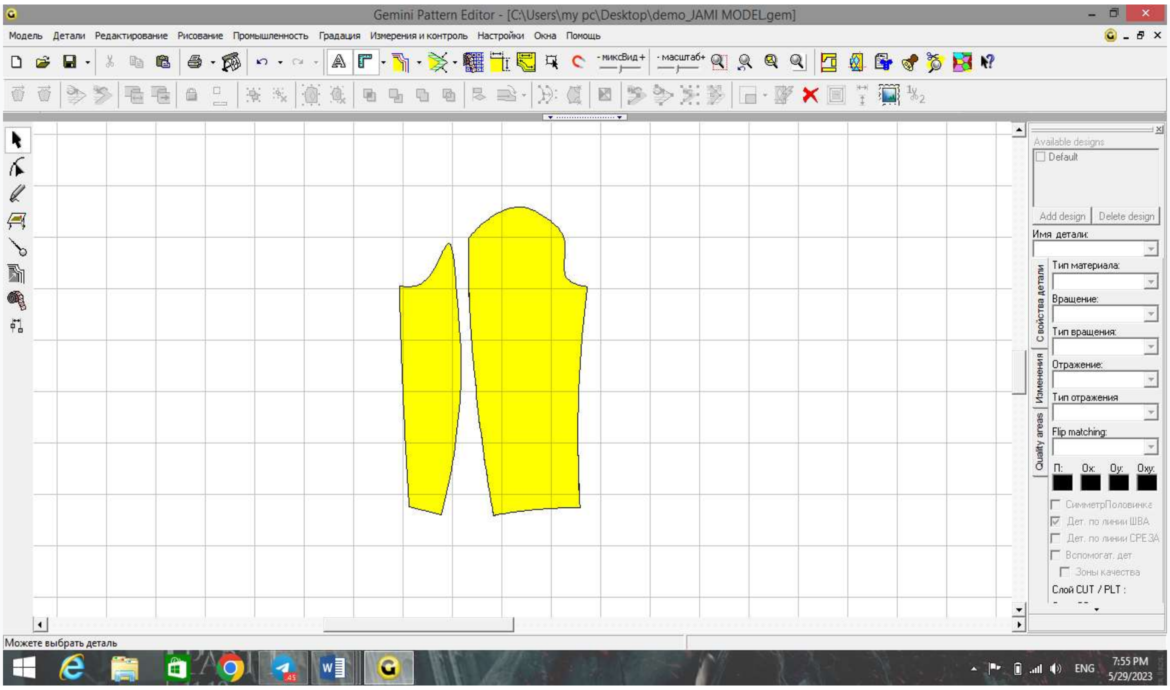

Figure 3. Clothing project in GEMINICAD

Molnia was used to combine the upper part with the lower part (kitel and skirt), [17, 18, 19] cover pockets are angled for comfort and design, and abrasion-resistant materials are used to reduce sleeve wear during use. [20] (Figure 4)

Fig. 4. Views of scientific innovation

Conclusion. This cloak is different from other cloaks in terms of construction and design. In the production of women's cloaks from artificial leather materials, innovations have been introduced to the currently available models and convenience has been created for consumers.

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METHOD OF DESIGNING SPECIAL CLOTHING BASED ON APPROVAL OF CONTAMINATION ASSESSMENT METHODOLOGY

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Abstract:

The article covers the issues of developing the informational and methodological support of the decision-making process on the formation of the assortment of special clothes. At the initial stage of design, the structure of the information-search process is proposed, which provides the search for graphic solutions of production clothing models based on the determination of the optimal zones of clothing contamination and wear areas in accordance with real operating conditions.

A graphic base of various constructive-technological solutions has been developed that allows expanding the functional modules of automated systems. The use of a graphical display base in the automated design of a production clothing collection significantly reduces the time of model design development and reduces the number of errors caused by the human factor.

Keywords: custom clothing, graphic design, design, sewing zone, automated systems.

Today, advances in science and technology in the world offer a wide range of opportunities for the production of special clothing of competitive quality, including innovative materials with high protection indicators, automated design systems (ALT) based on an intellectualization approach, aimed at operationally updating the range of clothing and increasing production efficiency. With the increasing technological competition, the importance of customer-oriented interactive design of not only household goods, but also industrial clothing is increasing. Opportunities to strengthen the creative work of designers and constructors based on the use of artificial intelligence methods in solving difficult formalized issues of interactive design of clothes [1] have been proposed. In [2,3], an information system was proposed that provides a complete and differentiated scope of the needs of various professional-production groups, providing an opportunity to solve project-organizational issues of special clothes, and a reference-search apparatus was created that provides the creative process of creating clothing models for groups with a set project status. However, the proposed information support of the formation of the assortment of production clothes does not provide a solution to the problem of creating sketches based on the direct dependence of the clothes on the factors of contamination and decay, the search for constructive-decorative, technological elements. Therefore, at the initial stage of design, it is required to solve the task of expanding the functional modules of automated systems in order to develop original solutions of special clothes that provide predictability and prolong the service life of special clothes in accordance with standard requirements.

This article describes the issues of developing the information-methodical support of the decision-making process on

the formation of the assortment of special clothes. At the initial stage of the project, the structure of the information-search process is proposed, which provides the search for graphic solutions of production clothing models, based on determining the optimal zones of the areas of contamination and decay of clothing in accordance with real operating conditions (Fig. 1).

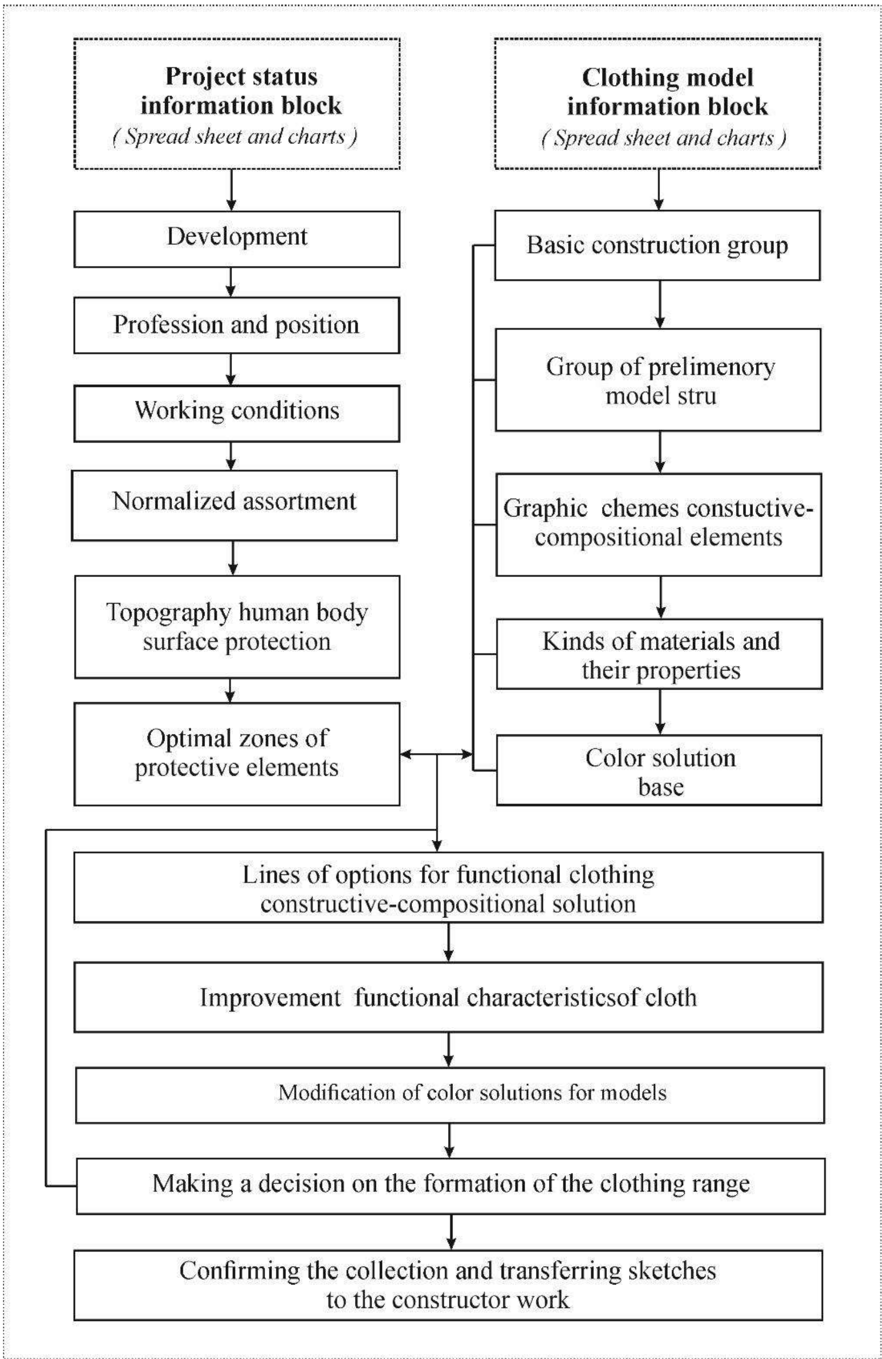

Fig. 1. The structure of the information-search process of forming the assortment of production clothes

The input data of the information-search process of creating a clothing sketch are: positions of employees of a specific enterprise, graphic information on clothing contamination zones by position, indicators of material types and properties, and clothing assortment units. The organization of the basis of the graphic

appearance of the clothing sketch is based on the provision of the basic basis and the structural-decorative, technological elements of the assortment unit according to the shape and silhouette of the proposed special clothing. The formation of sketches in the selected base structure is determined by graphic information on contamination zones and the relationship between constructive-decorative and

Based on the comparison of the graphical information of the pollution zones on the basic shape of the clothes and the parameters of the graphic solutions of the designed model, the modification coefficient is determined, which reflects the change of the parametric values of the shape of the article and structural lines. By judicious use of protective materials at the expense of changing the color solution, various options for the stylized image of sketches of production clothes are obtained, while preserving the integrity of the transformed image.

Today, criteria and methods of physiological-hygienic evaluation of special clothes according to climatic conditions have been developed, the relationship between technical parameters of materials and clothes has been determined [4-6]. The analysis of the materials used in the preparation of protective clothing against oils and acids [7] showed that today there is a wide range of protective fabrics and their use is aimed at increasing the quality of the designed product, while on the other hand it is difficult to choose this or that sample of the fabric. In addition, fabrics with high oil-acid protection properties are expensive, that is, they are almost not used in practice due to the unprofitability of using special clothes made of them for the enterprise, and the addition of additional components leads to a significant increase in the total weight of the clothes. It is worth noting that the number of companies in the world who want to provide their employees

technological elements. The solution of this task is based on the development of methods that allow to "recognize" the graphical solutions of models according to the zones of contamination defined according to professional positions. The implementation of recognition methods is carried out with expert knowledge that establishes a visual graphic representation of the clothing model.

In order to evaluate the compositional solutions of clothing models, it is necessary to optimize the variation of compositional-constructive parameters. In order to solve the tasks of determining the set of variable technical parameters, the criterion of optimality that ensures quality, and the limits of their variability, the special clothing of motor welders of the automobile industry, which wears out quickly as a result of regular acid and oil spills and acid spills in working conditions, was chosen as a research object.

with unique design work clothes that will introduce the company in the market is also increasing.

An analysis of existing analogs was carried out to determine the effect of the service life of the special clothing of motorists and welders protecting against oils and fats on the artistic and constructive solution of the product[8,9]. In order to determine the priority parameters of fabric and special clothing constructive-technological solutions, the erosion topography of the special clothing of auto mechanic workers at the end of their service life of the "Toshavtotamirkhizmat" center was studied based on the results of visual inspection. The degradation topography scheme was developed by dividing 100 suits (jacket and trousers) into high, medium and relatively contaminated zones according to the difference in the distribution of contamination on the surface of the garment (Figure 2).

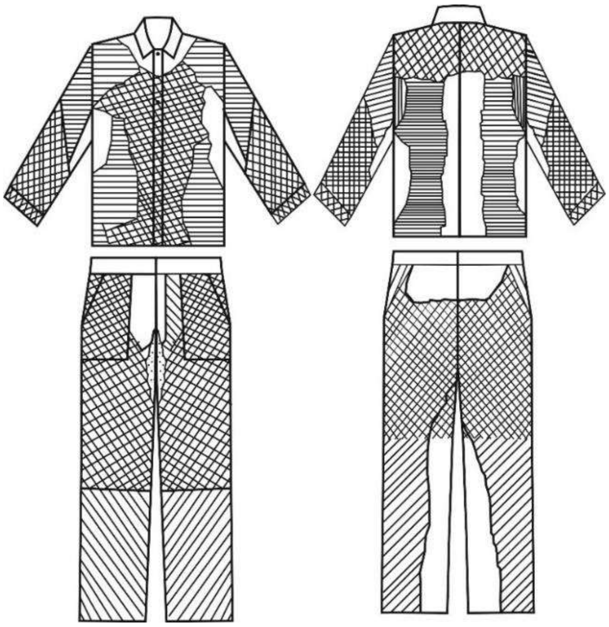

Figure 2. Degradation topography of special clothing of auto mechanic workers

By determining the optimal size of the protective element for the alternative use of protective materials during the development of a special clothing design, the creation of a special clothing design provides an opportunity to predict the service life of the item. From our side, a proposed method of assessing the level of contamination of different parts of special clothing based on changes in the physical and mechanical parameters of the material of the article [9] is presented. This method refers to the color change (darkening) of the surface of the material due to contamination from acids, fats and oils, and the degree of contamination is determined using the optical evaluation method. As a result of pollution, particles of oils and impurities fall on the surface of the fabric, the texture and color of the fabric change, which is visually visible as darkening or discoloration of the fabric surface. The degree of darkening and the size of the darkened area can indicate the degree of contamination. The color of the material affects the visual perception of the degree of pollution: the lighter the color of the material, the more clearly the degree of darkening is determined. Figure 4 shows the process of identifying contamination zones on an Empyrean Panalytical X-ray diffractometer.

According to the results obtained on the Malvern Panalytical Empyrean diffractometer, the XRD data of the contamination zones of special clothes were recorded using an analytical diffractometer with CuKa (λ = 1.54 Å) radiation. In this experiment, the accelerating voltage of the radiation generator was set to 45 kV and the current to 40 mA. X-ray diffraction reflexes were recorded in the Bragg-Brentano beam geometry at a value of 2 theta angle from5 degrees to 80 degrees ($2\theta = 5° - 80°$) at a constant scanning speed of 0.33 degrees/min [10-12].

ISSN 2181-8622

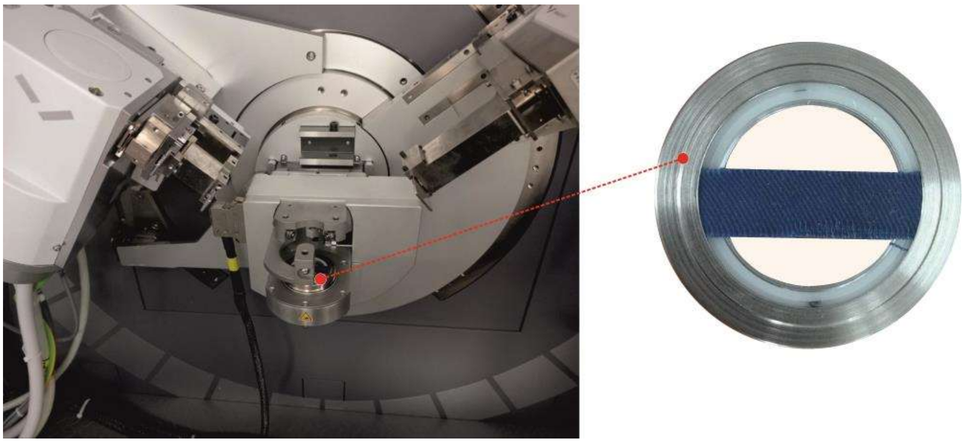

Figure 3. Empyrean Panalytical X-ray Diffractometer Detection Process for Contamination Zones

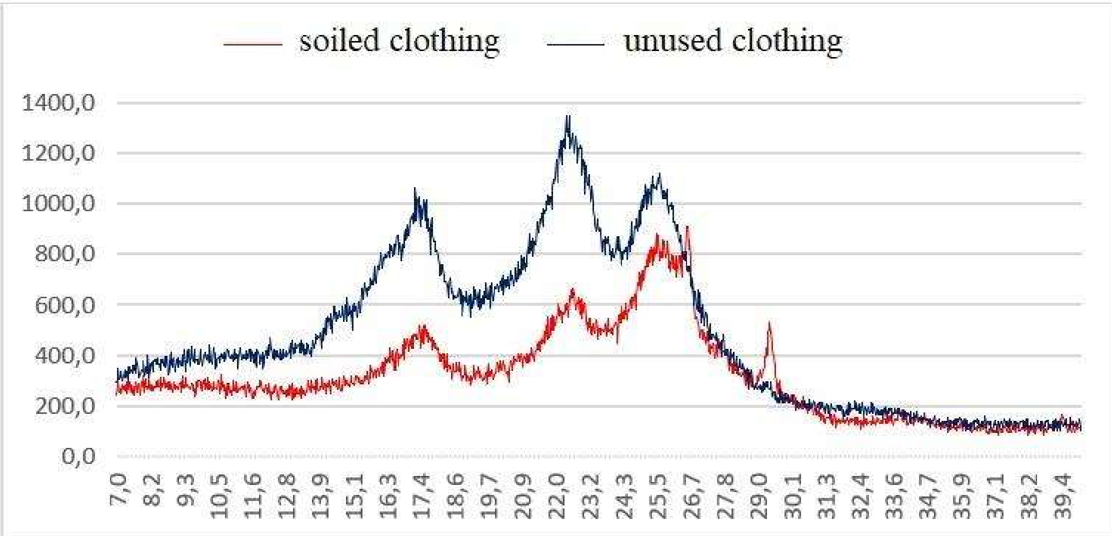

Figure 4. Empyrean Panalytical x-ray diffractometer results from unused and soiled clothing surfaces

According to the measurement results of the unused clothing surface, the value of the light reflection in the first 10 degrees of the 2 theta angle is in the range of 298 to 415 intensity, in unwashed clothing this indicator is in the range of 305 to 366 intensity, in moderately soiled clothing it is in the range of 351 to 373, in soiled clothing it is in the range of 245 to 308 intensity.

At an angle of 20 degrees of 2 theta, the value of the reflection of the light is 680 in unused clothes, 547 in unsoiled clothes, 471 in moderately soiled clothes and 369 in intensively soiled clothes, while at angles of 30 and 40 degrees it is 239 and 116 in unused clothes, 216 and 119 in unsoiled clothes, and 192 in moderately soiled clothes. and 112, 244 and 100 intensity in Soiled clothes were noted.

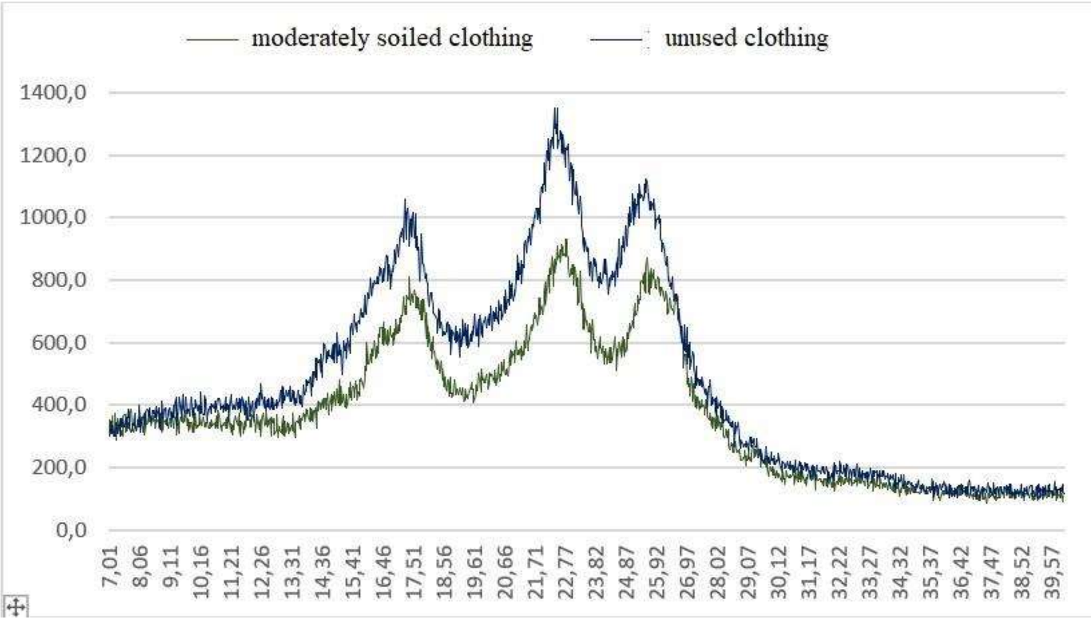

Figure 5. Results for unused and moderately soiled clothing

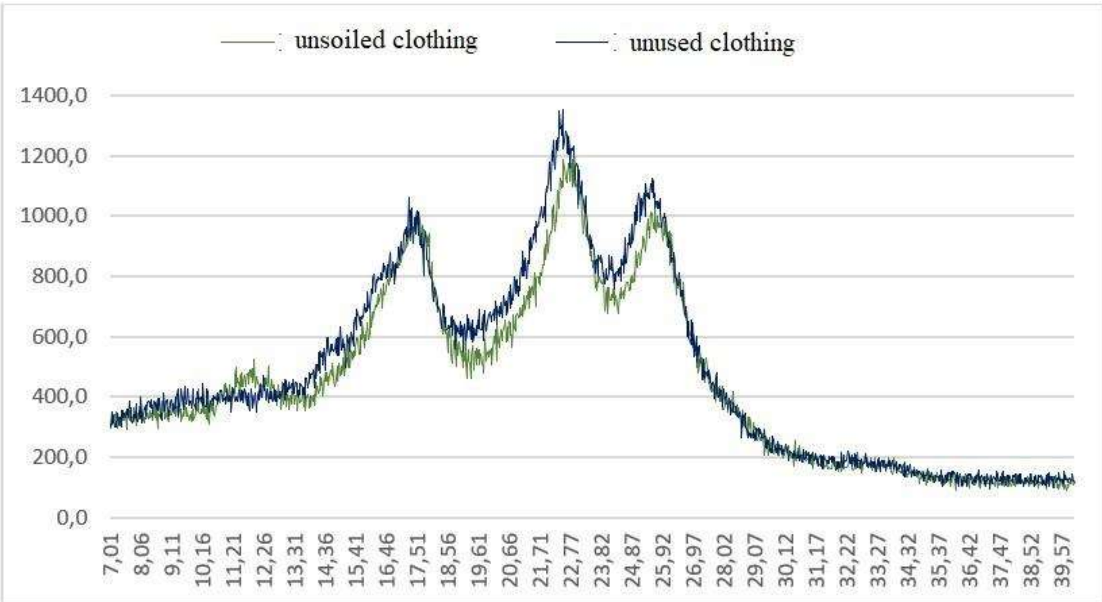

Figure 6. Results for unused and unsoiled clothing

The highest intensity index was recorded at 22.79 degrees of 2 theta angle, and it was found to be 1222 in unused clothes, 1175 in unsoiled clothes, 931 in moderately soiled clothes, and 628 in dirty clothes (Figures 5, 6, 7).

The system of transformation of graphic solutions of the clothing model was implemented in the existing software-methodological complex in the form of a test form of the information technology component. The development of mathematical support for the process of geometric transformation of the clothing model allows to transform the item in the automated mode of graphic solutions. The transformation of clothing structural-compositional solutions on the basis of the selected basis allows to expand the range of special clothing and to use protective elements effectively. In Fig. 8, at the stage of creating a constructive-decorative, technological solution of clothing in accordance with real operating conditions,

several different solutions of special clothing were proposed and put into production on one basic basis, with the rational use of protective material by determining the optimal dimensions of the contamination zone and protection area of special clothing.

Taking into account the working conditions of workers and topography of wear of special clothing, parameters in the analysis of existing model analogues, a model of special clothing was developed using protective materials, and an experimental sample was prepared at "Golden Ring" LLC.

Figure 7. General view of a special clothing model using protective materials according to the contamination topography

Thus, at the initial stage of design, a methodical support of the information-search process was developed, which provides the search for graphic solutions of special clothing models based on the determination of the optimal zones of areas of contamination and decay of clothing in accordance with real operating conditions. Tools for evaluating the effectiveness of various constructive-technological solutions have been developed to form a range of special clothes that allow expanding the functional modules of automated systems. The use of a graphical display base in the automated design of a collection of production clothes can significantly reduce the time of construction development and reduce the number of errors caused by the human factor.

In the design of protective clothing, at the stage of creating a constructive-decorative, technological solution of clothing in accordance with real operating conditions, special clothing serves to rationally use protective material and extend the service life of special clothing by determining the optimal dimensions of the contamination zone and protection area. It allows to assess the level of compliance of the range of protective clothing to the real structure of production-consumer situations in the formation of the assortment of special clothing and to make a decision.

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UDC 677.21.621.547

PRACTICAL AND THEORETICAL ANALYSIS OF THE RESULTS OBTAINED IN THE PROCESS OF CLEANING COTTON FROM IMPURITIES

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Abstract:

Objective. In the article, the cleaning efficiency of the machine in the equipment for cleaning seed cotton from small and large impurities, the main control developments and calculation processes in the selection of the technological parameters of the cleaners are considered.

Medhods The main essence of the cleaner is to reduce the binding force between the waste particle and the fiber under the influence of dynamic force, and the theoretical aspects of its separation from the raw material mass have been determined.

Results. Experiments were conducted at different speeds to determine the performance and cleaning efficiency of pile drum and saw drum.

Conclusion. Calculation of forces acting on pile drum and pile, calculation of technological parameters of cleaning machines; Calculation of the productivity of the drum with a pile, calculation of the drum with a saw, calculation of the drum with a brush that separates cotton from the drum with a saw; It is carried out according to the method of calculation of the working rollers of the cleaning drum.

Keywords: cotton, technology, impurity, theory, equation, forces, model, fiber.

Introducation. The main tasks of cleaning machines, their classification, the main technical requirements for cotton cleaning machines, the main working bodies of the technological process; Calculation of forces acting on pile drum and pile, calculation of technological parameters of cleaning machines; Calculation of the productivity of the drum with a pile, calculation of the drum with a saw, calculation of the drum with a brush that separates cotton from the drum with a saw; It is carried out according to the method of calculation of the working rollers of the cleaning drum.

Medhods. Experiments were conducted at different speeds to determine the performance and cleaning efficiency of pile drum and saw drum. In the test

S 6524, cotton raw material grade was used, its initial quality indicators: 2 industrial grade, 2nd class, moisture 9%, dirtiness 5.16%, coarseness 1.5%, degree of mechanical damage to the seed 2.17%. A selected sample of cotton raw material was transferred to the new ginning equipment, samples of cleaned cotton raw material were taken and laboratory analysis was carried out.

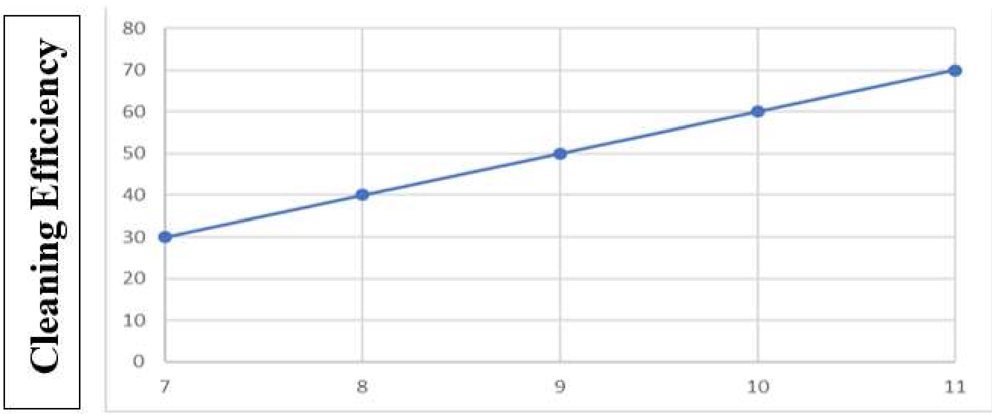
Results. The results of these analyzes of the effect of cleaning frequency on cleaning performance at different performance levels are presented in Table 1. As can be seen from the table, when the work productivity is 4 t/h in the cleaning of highly contaminated cotton raw materials, the cleaning efficiency increases from 45.8% to 65.1%. given in the table.

Table 1

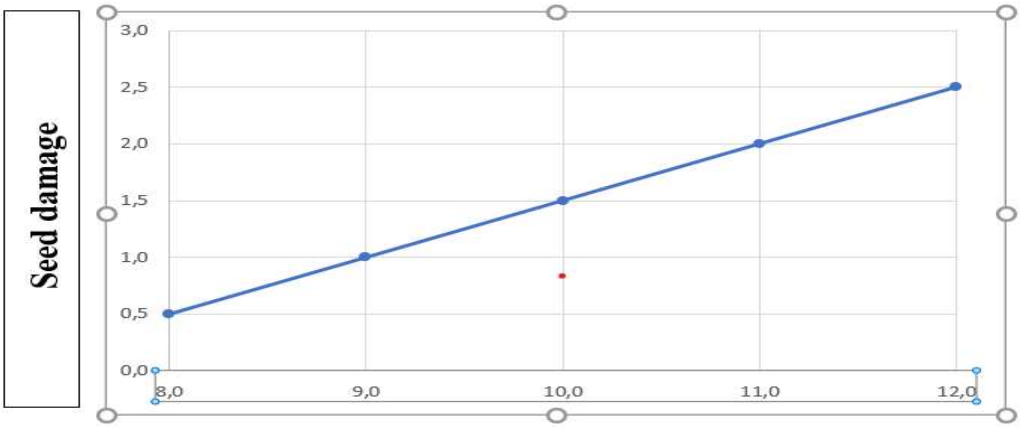
Experiment plan

Selection variety	Angle speed	Cotton x/a soiling		The seed Injury		Free fiber		Clean Efficient	
		Before cleaning	From cleaning after	Cleaning before	Cleaning after	From cleaning after	Cleaning after	General	Йи-рик ифл
				Free fiber 9.14 %					
C-6524	7,8,	5,16	2,86	2,17	2,17	0,16	0,17	45,8	23,8
	8,9,	- /-/ -	2,23	- /-/ -	2,20	- /-/ -	0,18	56,9	33,1
	9,10,	- /-/ -	1,96	- /-/ -	2,25	- /-/ -	0,20	63,2	36,1
	10,11,	- /-/ -	1,84	- /-/ -	2,32	- /-/ -	0,18	65,6	41,9
	11,12,	- /-/ -	2,03	- /-/ -	2,45	- /-/ -	0,17	62,0	47,6
				Hand skin cotton moisture 8,23 %					
C-6524	7,8,	2,69	1,41	0,02	0,02	0,14	0,14	48,5	22,6
	8,9,	- /-/ -	1,08	- /-/ -	0,03	- /-/ -	0,15	60,8	30,3
	9,10,	- /-/ -	0,92	- /-/ -	0,08	- /-/ -	0,17	66,7	34,0
	10,11,	- /-/ -	0,87	- /-/ -	0,20	- /-/ -	0,15	63,2	35,2
	11,12,	- /-/ -	0,96	- /-/ -	0,40	- /-/ -	0,14	65,1	30,7

Table of growth of cleaning efficiency due to differential change of pile drum speed



The pile drum in the cleaner is highly differentiated determine the spee



Linear speed of pile drum, m/s

1) Incoming parameters
2) X1-Supplier speed
X2-Pile drum rpm
X3-Saw drum rpm

table 2

Experiment plan 1

Factors	X_{Max}	X_{Min}	$\Delta = \frac{X\max - X\min}{2}$	$Xcp = \frac{X\max + X\min}{2}$
1.Provider speed	25	15	5	20
2. Pile b-n speed	500	400	50	450
3. Arrali b-n speed	350	250	50	300

Table 3

Experiment plan -2

Factors	X_{Max}	X_{Min}	$\Delta = \frac{X\max - X\min}{2}$	$Xcp = \frac{X\max + X\min}{2}$
1.Provider speed	25	15	5	20
2. Pile drum speed	500	400	50	450
3. Saw drum speed	400	300	50	350

An outgoing parameter:

Efficiency of U1-purifier, t/s;

4 Table

№ т/р	X_1	X_2	X_3	Y_{u1}	Y_{u2}	Y_{ucp}	S_u^2	$\bar{Y}_u$	$R_u(\%)$
1	-	-	-	2300	2400	2350	5000	4.25	4.25
	+	-	-	2500	2700	2600	20000	1.68	1.68
3	-	+	-	2400	2500	2450	5000	4.08	4.08
4	+	+	-	3100	3300	3200	20000	1.37	1.37
5	-	-	+	2700	2900	2800	20000	3.58	3.58
6	+	-	+	3400	3650	3525	31450	2.04	2.04
7	-	+	+	3200	3400	3300	20000	3.03	3.03
8	+	+	+	3800	4100	3950	45000	1.11	1.11

We process the obtained test results in a separate statistical method for each factor in a certain sequence.

1) In the same number of parallel tests, we check the homogeneity of the dispersion, the dispersion of the results: S_u^2

$$S_u^2 = \frac{\sum_{p=1}^{m}(Y_{up} - Y_{ucp})^2}{m-1} = \frac{\sum_{p=1}^{2}(Y_{up} - Y_{ucc})^2}{1}.$$

Here u - variant serial number ($u = 1.2..N$).

$p = 1.2.3..m$ - sequence number of parallel experiments, m =2 $\bar{y}_u = \frac{1}{m}\sum_{p=1}^{m}\bar{y}_{up}$ -

Average number of trials in each option.

Statistics ($S_{u(\max)}^2 = S_8^2 = 45000$ - maximum value in options):

$$G = \frac{S_{u(\max)}^2}{\sum_{u=1}^{N} S_u^2} = \frac{45000}{166250} = 0,271 \qquad (4.4)$$

Check the Cochrane criteria: G_{α,k_1,k_2} - values are taken from table data. α - significant level ($0 < \alpha < 1$), $k_1 = N$, $k_2 = m-1$ number of degrees of freedom. In our case $\alpha = 0.05$, $m = 2$, $N = 8$, $G_{\alpha,k_1,k_2} = G_{0.05,8,1} = 0.68$, $G < 0.68$ because it is appropriate, the homogeneity of the variance is fulfilled in all variants of the parallel experiment, then the average value of the variance can be chosen $S_y^2 = \frac{1}{N}\sum_{u=1}^{N} S_u^2 = \frac{166250}{8} = 20781$

(4.6)

2) We calculate the regression coefficients using the following formula:

$$b_0 = \frac{1}{N}\sum_{u=1}^{N}\bar{y}_u, \quad b_i = \frac{1}{N}\sum_{u=1}^{N}X_{iu}\bar{y}_u, \quad b_{ij} = \frac{1}{N}\sum_{u=1}^{N}X_{iu}X_{ju}\bar{y}_u, \quad b_{ijk} = \frac{1}{N}\sum_{u=1}^{N}X_{iu}X_{ju}X_{ku}\bar{y}_u, \qquad (4.7)$$

The numerical coefficients of the regression coefficients have the following form:

$b0 := 3021.875000$ $b1 := 296.8750000$ $b2 := 203.1250000$ $b3 := 371.8750000$

$b12 := 53.1250000$ $b13 := 46.8750000$ $b23 := 28.1250000$ $b123 := -71.8750000$

We determine the coefficients using the table values and write the regression equation: $\hat{y} = b_0 + \sum_{i=1}^{k} b_i x_i + \sum_{i<1}^{k} b_{ij} X_i X_j + \sum_{i<j<l}^{k} b_{ijl} X_i X_j X_l$

$$y := 3021.875000 + 296.8750000\ X1 + 203.1250000\ X2 + 371.8750000\ X3 + 53.1250000\ X1\ X2 + 46.8750000\ X1\ X3 + 28.1250000\ X2\ X3 - 71.8750000\ X1\ X2\ X3$$

(4.8)

3. We check the significance of the regression coefficients according to the Student's criterion. Initially, all regression coefficients in the same confidence interval must meet the following condition:

$$\Delta b = t_{\alpha,k} \frac{S_y}{\sqrt{N}} ,$$

Here $t_{\alpha,k}$ - Student criteria, α - level of importance, $\alpha = 0.05$, $k = N(m-1)$ - number of degrees of freedom.

If the regression coefficient is above the confidence interval, then the coefficients are significant:

$$|b_0| \geq \Delta b, |b_i| \geq \Delta b, |b_{ij}| \geq \Delta b, |b_{ijk}| \geq \Delta b \quad (4.9)$$

Let's look at the following $t_{0.05,8} = 2.78$, $\Delta b = 2.78 \frac{S_y}{\sqrt{N}} = 2.78 \frac{\sqrt{20781}}{\sqrt{8}} = 141.69$

(4.9) significant coefficients in the regression equation according to inequality b_0, b_1, b_2 ва b_3 is written as the regression equation

$$y := 3021.875000 + 296.8750000\ X1 + 203.1250000\ X2 + 371.8750000\ X3 \quad (4.10)$$

Conclusion. If the regression equation is taken in the form (4.8), the variance test is equal to zero. In this case, everyone $N = 2^k$ regression coefficients were calculated N significant model fit is fully achieved. Such planned experience is said to be saturated. If some insignificant coefficients (4.8) are removed from the regression equation, the model should be checked for adequacy again. Compatibility experimental values are input parameters (Y_{cpu}) with the book value ($\bar{Y}_u$) When the level of various output factors is different from each other, it is determined by the following formula: $R_u = 100 \left| \frac{Y_{cpu} - \bar{Y}_u}{Y_{cpu}} \right|$

($u = 1....8$) (4.11)

If the full regression equation (4.8) is replaced by the reduced (4.9), then (4.11) is the largest difference. Add two terms to the regression equation to reduce variance b_{12} and b_{13} we write keeping

$$y := 3021.875000 + 296.8750000\ X1 + 203.1250000\ X2 + 371.8750000\ X3 + 53.1250000\ X1\ X2 + 46.8750000\ X1\ X3 \quad (4.12)$$

4. We enter the values obtained using the obtained regression equation and the value of the resulting differences in Table 3

To check the adequacy of the regression equation (4.12) according to the Fisher criterion, we use the residual variance formula ($k = 3$ -number of incoming factors):

$$S_{oc}^2 = \frac{\sum_{u=1}^{N}(\overline{Y}_u - Y_{cpu})^2}{N-k-1} = = \frac{\sum_{u=1}^{8}(\overline{Y}_u - Y_{cpu})^2}{8} = 12727$$

Let's look at these statistics: $F = \frac{S_{oc}^2}{S_y^2} = 0.612$. Fisher's criterion F_{α,k_1,k_2} is accepted here α - аҳамиятлилик сатҳига қараб $k_1 = N-k-1 = 4$, $k_2 = N(m-1) = 8$, we find from the table: $F_{\alpha,k_1,k_2} = 3.01$ $F < F_{\alpha,k_1,k_2}$ since the inequality holds, the concordance hypothesis is valid.

Table 5

У₂ - cleaning efficiency of cotton,%;

№ т/р	X1	X2	X3	Y_{u1}	Y_{u2}	Y_{ucp}	S_u^2	$\overline{Y}_u$	$R_u(\%)$
1	-	-	-	37	41	39	0.765	38.12	2.243
2	+	-	-	39	44	41.5	1.890	48.87	3.313
3	-	+	-	38	42	41	0.391	40.62	1.562
4	+	+	-	44	49	46.5	1.265	45.37	2.419
5	-	-	+	41	46	43.5	1.410	43.87	0.862
6	+	-	+	46	53	49.5	1.265	48.37	2.272
7	-	+	+	42	51	46.5	0.015	46.37	0.268
8	+	+	+	47	54	50.5	0.391	51.12	1.237

Statistics ($S_{u(\max)}^2 = S_8^2 = 40.5$ - the maximum value of the variance in options):

$$G = \frac{S_{u(\max)}^2}{\sum_{u=1}^{N} S_u^2} = \frac{40.5}{143} = 0{,}283$$

$G_{\alpha,k_1,k_2} = G_{0.05,8,1} = 0.68$, $G < 0.68$ since it is reasonable that the homogeneity of the variance is fulfilled in all variants of the parallel experiment, then the mean value of the variance can be chosen

$$S_y^2 = \frac{1}{N}\sum_{u=1}^{N} S_u^2 = \frac{143}{8} = 17.785$$

The numerical coefficients of the regression coefficients have the following form:

$b0 := 44.62500000$ $b1 := 2.375000000$ $b2 := 1.250000000$ $b3 := 2.875000000$

$b12 := .250000000$ $b13 := .125000000$ $b23 := -.250000000$ $b123 := -.750000000$

We determine the coefficients using the table values and write the regression equation:

$$y := 44.62500000 + 2.375000000\ X1 + 1.250000000\ X2 + 2.875000000\ X3 + .250000000\ X1\ X2 + .125000000\ X1\ X3 - .250000000\ X2\ X3 - .750000000\ X1\ X2\ X3$$

All regression coefficients in the same confidence interval must meet the following condition:

$$\Delta b = t_{\alpha,k}\frac{S_y}{\sqrt{N}} = 2.73\frac{\sqrt{17.785}}{\sqrt{8}} = 4.55 \quad ,$$

(4.9) is a significant coefficient in the regression equation according to inequality is written as the regression equation

$y = b_0 = 44.625$

If the full regression equation is reduced

$y = b_0 = 44.625$ then the biggest difference is 14.42%.

Add two terms to the regression equation to reduce variance b_1 , b_2 and b_3 we write keeping

$$y := 44.62500000 + 2.375000000\ X1 + 1.250000000\ X2 + 2.875000000\ X3$$

We enter the values obtained using the obtained regression equation and the value of the resulting differences in table 4

Using the residual variance formula ($k = 3$ -number of incoming factors) let's find out:

$$S_{oc}^2 = \frac{\sum_{u=1}^{N}(\overline{Y}_u - Y_{\text{ср}u})^2}{N-k-1} = = \frac{\sum_{u=1}^{8}(\overline{Y}_u - Y_{\text{ср}u})^2}{8} = 1.531$$

Statistical value $F = \frac{S_{oc}^2}{S_y^2} = 0.0566$

$F < F_{\alpha,k_1,k_2}$ since the inequality holds, the concordance hypothesis is valid.

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GROWING, STORAGE, PROCESSING OF AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

SCIENTIFIC BASIS FOR THE PRODUCTION TECHNOLOGY OF FRUIT LOZENGES (MARSHMALLOW)

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Abstract:

Objective. The article is based on the importance of enriching pastille with components useful for the human body and introducing biologically valuable substances into the receptor of this confectionery product. The technological scheme for the production of finished products is selected. The results of microbiological, sanitary and chemical analyzes of raw materials and finished products are presented.

Research on the processes of preparation of confectionery products based on plant raw materials of high nutritional and biological value, expanding the range of pastila products.

Results. In order to study the microbiological indicators of pastilan, test-samples were prepared in laboratory conditions. Sanitary and microbiological analysis was carried out in order to determine the shelf life of these samples. To determine the shelf life of pastilles, observations of the dynamics of microbiological indicators were carried out for 210 days, and the shelf life was set at 180 days . At the same time, the optimal conditions for its storage Pastila confectionery came to the requirements of gost 6441-2014, and the storage temperature was (18 ± 3)° C and the relative humidity of the air (no more than 75%).

Conclusion. The situation in the world confectionery market shows a stable trend towards increasing production, expanding the range of products, improving the quality of raw materials, reducing its cost and increasing the consumption of confectionery products, which may indicate an increase in well-being and living standards of the population. At the expense of an herbal supplement with antioxidant properties, the biological value of the finished product increases, and an extension of the shelf life can be achieved. According to the results of the study, the eneretic value of fruit lozenges prepared on the basis of the above recipe was calculated.

Keywords: prophylaxis, pastila, assortment, functional product, enriched products, prescriptions, microbiological indicators.

Introduction. Confectionery products are common in the world, among which pastila products occupy a special place, and it is important to expand the range of these products, that is, to develop or improve ways to reduce the calories of products, as well as increase their energy and nutritional value [1;2;3].

Pastila is a pastila product made from fruit and berry puree that contains pectin, essential micro and microelements and other biologically active substances that improve liver, gastrointestinal and cardiovascular function. Compounds that form the consistency of pastilles are divided into the following types: fruit puree is made from fruit puree and whipped proteins, special agar-sugar-patokali syrup is added to it to strengthen the consistency of whipped glue, foam and small pores.

The relevance of improving the technology of making Pastila is determined by the fact that the studied, that is, confectionery products, are in great demand among the population of our country. It is also to strengthen human oraganism for preventive purposes to fight viral and Infectious Diseases [4].

Currently, the population's diet consists of foods that are varied and complex in their recipe composition. Accordingly, a new direction of the food industry is developing-the design of food products. Food design refers to complex multicomponent food production processes that can fully meet consumer demand, meet regulatory nutritional requirements and principles, have a set of essential nutritional properties [5;6].

Methods. Designing new foods with a complex polycomponent composition allows solving a number of problems [7]:

- provides the human body with physiologically useful nutrients in the necessary set;

- formation of this direction, taking into account the possibility of enriching the products of physiological influence on the human body with mixtures and various biologically active substances, micro - and Macroelements in the composition of the receptor;

- safety of finished products, quality indicators, modeling and forecasting consumer properties.

One of the major issues in the design of the multicomponent nutritional system is the provision of receptor composition ratios and optimal sets in the development of new types of confectionery product with functional properties [8;9]. Taking into account the above, we offer a technological scheme for the production of fruit and vegetable lozenges with a high biological value. Finished products are aimed at ensuring that the human body lacks the necessary macro - and micronutrients of vitamins, minerals and vitamins [10].

As objects of research, samples of fresh and dried local plant raw materials were selected: apples, haynoli (plums) and apricots, beets, grapes, beans, carrots, beets, as well as medicinal plants. In this scientific research work, we modeled and developed new types of lozenges recipes with a certain chemical composition and functional orientation.

The recipe consists of freshly picked and dried fruits, as well as maxillary medicinal plants. Such dessert products are basically a product consisting of 60 to 80% fruit mass. Low-waste innovative technologies for obtaining new types of fruit lozenges have been developed using effective technological methods that reduce the loss of biologically active substances in the finished product [11;12].

Table 1

Fruit pastila recipe

№	Fruit pastila components	Amount
1	Apple puree	60
2	Plum	20
3	Patoka	10
4	Agar	5,5
5	Herbal supplement	4,5

In terms of organoleptic indicators, pastilles must meet the requirements presented in Table 2 [13].

Scheme 1. Technological scheme of pastille preparation technology

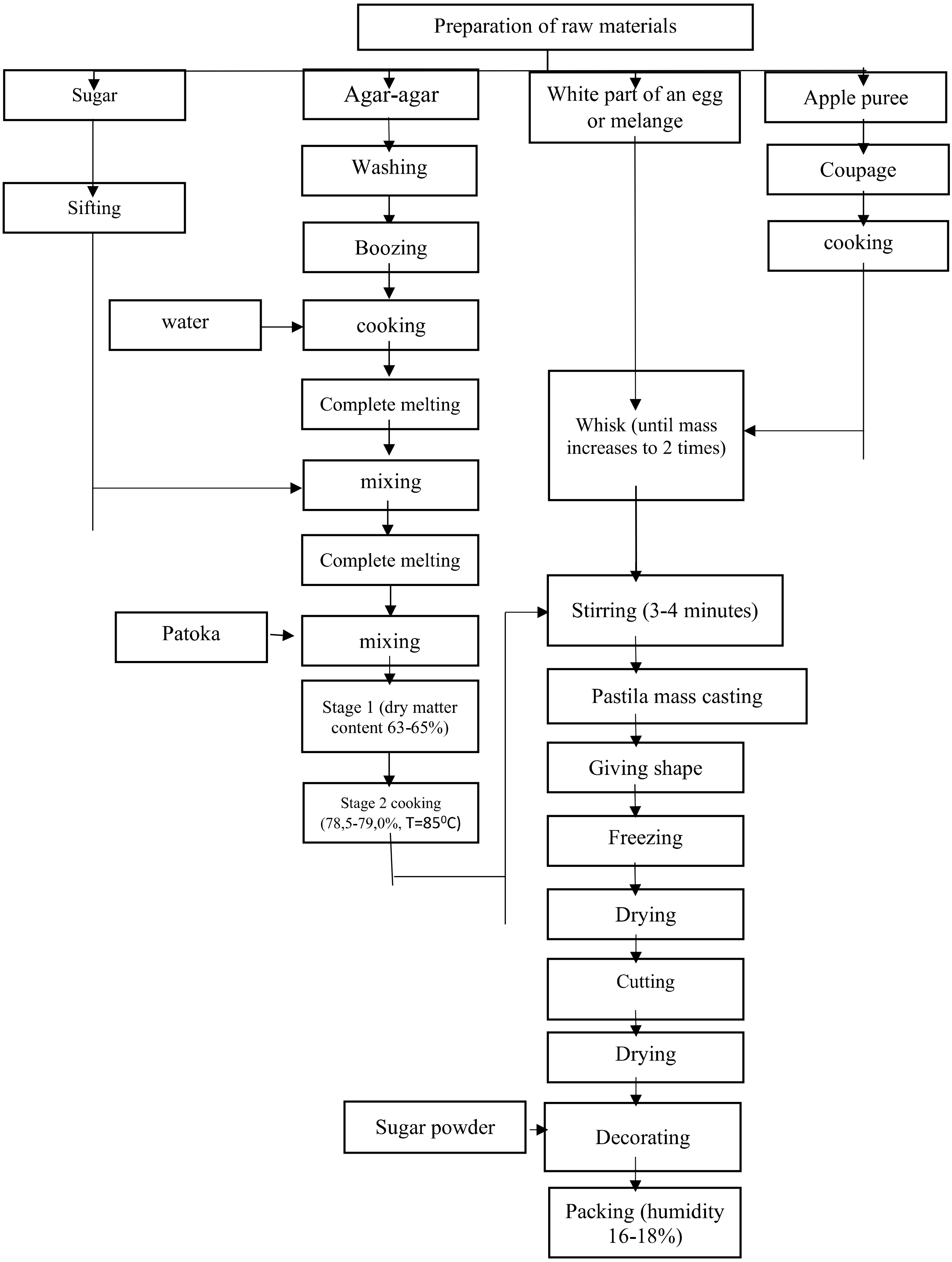

Table 2

Organoleptic indicators of Fruit Pastille prepared in laboratory conditions

Nomination of indicators	Describtion
Taste and smell	Typical of the basic and rough raw materials used, the degree of sweetness is in meiori, without extraneous flavors. KHIDI is fragrant, typical of raw materials in its composition. Foreign taste and smell are not allowed
Colour	Typical of the color of the raw materials used. It is allowed to be dark or light bright color
Consistency	Particles of crushed fruit and additional components are in a dense state, and light decomposition is allowed. It is in a slightly soft state when pressed with a crush
Appearance	Rectangular or round, with a smooth surface, the thickness is the same, intact, the edges are not broken, keep their shape during packaging and transportation

Results. In order to study the microbiological indicators of pastilan, test-samples were prepared in laboratory conditions. Sanitary and microbiological analysis was carried out in order to determine the shelf life of these samples.

Determining the shelf life of a food product involves experimental testing of the food degradation process, which results in determining the time that coincides with the end of its shelf life [14;15]. The basis of the process of substantiating the shelf life of food products is to conduct microbiological, sanitary and chemical research, assessing the organoleptic properties of product samples during storage at temperatures established in regulatory or technical documents. A microbiological analysis was carried out for all controlled groups of microorganisms of raw materials and finished products used in a complete sanitary and epidemiological assessment of the paste. In the process of preserving pastilles, microbiological studies were carried out on the following, and the amount of QMAFAnM and yeast (fungi) contained in the finished product was determined. Microbiological indicators for 210 days to determine the shelf life of pastilles dynamics.

Table 3

Microbiological indicators of the finished product

Indicators	Fruit pastilas	According to SanQvaM 6441-2014, the limit of access is no more than mg / kg
Pathogens including salmonella in 100 g of the product	Not available	Not allowed
BGKP (100 g -da)	Not available	Not allowed
Yeast is no more than KOE/g	Not available	100
Fungus do not exceed KOE/g	Not available	100

Discussions. Based on the above-mentioned technological scheme of production of fruit lozenges, fruit lozenges prepared in laboratory conditions were assessed as meeting the requirements of Sanquam. Also, the product was stored for

210 days, samples were taken from fruit lozenges stored every 30 days and microbilogic indicators were checked, and for 180 days the product did not observe the development and bijection of microorganisms.

Conclusion. Thus, the situation in the world confectionery market shows a stable trend towards increasing the volume of production, expanding the range of products, improving the quality of raw materials, reducing its cost and increasing the consumption of confectionery products, which may indicate an increase in well-being and living standards of the population. At the expense of an herbal supplement with antioxidant properties, the biological value of the finished product increases, and an extension of the shelf life can be achieved. According to the results of the study, the eneretic value of fruit lozenges prepared on the basis of the above recipe was calculated.

The development and mass use of confectionery products made on the basis of plant raw materials of high nutritional and biological value is a promising direction for the solution to the problem of lack of nutrients, which is rare in the diet of the population, and it is important to expand the range of such products.

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UDK 637.138:637.35.04

DEVELOPMENT OF TECHNOLOGY TO INCORPORATE DEHYDRATED MURUNGA LEAF POWDER IN PANEER CHEESE

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Abstract:

Objective. Murunga (*Moringa oleifera*) is a popular plant and the leaves and fruits are very famous for food but it is underutilized in Sri Lanka even though it has some functional properties. It has some essential oil fractions which provide functional properties. This study was carried out to develop a technology to incorporate Murunga leaf powder in paneer cheese and analyze the chemical and microbial composition, and its' acceptability using (soft and hard paneer). Preparation of paneer was done in a usual way and citric acid was used as a coagulant for all treatments and treated with 0.50, 1.00, 1.50, and 2.00% of Murunga leaf powder for this experiment named T^1 to T_4 respectively. Sensory analysis was conducted (30 panelists) by using hedonic scale (5-point) to evaluate the acceptance level of Murunga incorporation in paneer.

Methods. Cow milk was used for this experiment and fat, and solid non-fat of that milk were analyzed using the Gerber method and standard equation to find Solid non-fat. To produce quality paneer cheese it is recommended to add 0.08-0.15% of ($CaCl_2$) Calcium chloride into the milk to induce coagulation.

Results. The study was conducted to characterize the paneer by having chemical analysis of the Murunga leaf powder incorporated paneer made with different percentages. The protein contents were analyzed just after 10th, 20th, and 30th days in ambient conditions. It shows that there were no significant differences in the protein percentages but slight rises were observed in pH, reduction in the total plate counts with Murunga leaf powder added paneer sample compared with control. Also, coliform counts were not observed throughout the storage period but the sensory analysis showed that the flavor, color, odor and overall acceptability of samples were found significantly different ($P<0.05$). This illustrates that the Murunga leaf powder incorporated paneer has high acceptability and could be potentially used as a functional ingredient, especially for antimicrobial activity, extending the shelf life and increasing the antioxidant ability in paneer and T_3 was selected as the best percentage for paneer cheese.

Conculusion. Dehydrated Murunga leaf powder added to paneer has high acceptability especially T_3 is identified as the best percentage. Also, it has effects on self-life improvement of paneer due to the inhibitory effect against microbes. Therefore, Murunga leaf powder could be used as a preservative in dairy products. The amount of Murunga leaf powder (1.5%) could be considered the acceptable amount for paneer cheese production.

Keywords: Murunga leaf powder, paneer cheese, antimicrobial activity, shelf life.

Introduction. Paneer is a kind of cheese product produced by heat treatment of milk and acid coagulation. For the purpose of acid; lactic, citric, tartaric and acetic acid are usually used in the industries. Organic acid is also important in paneer production because of chemical hazards. Organic acids such as lactic or its salt, citric, lime and lemon juice are used as coagulating agents in paneer manufacturing. The by-product formed during the processing is named whey which is removed by draining through filtration and pressing mechanically to have a hard paneer and keep it for a long time. It is having so many nutrients such as protein, fat, so many minerals and vitamins [1]. Paneer cheese is having milk constituents but there is a loss of lactose, water soluble proteins, some vitamins and minerals [2]. The chemical composition of paneer is 22–25% fat and 16–18% protein and a lower level of around 2.0–2.7% of lactose [3].

So many techniques studied and developed to process of paneer according to the consumer demand, and also to improve functionality, bioactivity and sensory attributes. Pasteurization of milk reduces the harmful microbes and slightly denatures proteins apeacially whey and reduces solubility of colloidal form of calcium phosphates [4].

Functional ingredient-added paneer is not available in the market and it is having less value addition due to its shelf life being limited to a maximum of one month. It is rich in antioxidant compounds. Isothiocyanates is a component which has the antibiotic and anti-carcinogenic properties [5]. The anti-nutritional factors are available in Murunga leaf powder such as tannins, lecithins and protease inhibitors. Also, they have a balanced amount of functional amino acids, vitamins A, and C sources, and antioxidants [6]. Murunga leaf extracts are having 13.9% of Hexacosane, 13.3% of pentacosane and 11.4% heptacosane [23]. These are essential oils, and the relevant components of the oil were obtained from Murunga leaves in another research where pentacosane (17.4%), hexacosane (11.2%) and (*E*)-phytol (7.7%) [24].

Therefore, this study was planned to incorporate Murunga leaf powder in different percentages 0.50, 1.00, 1.50 and 2.00 names as T_1 to T_4 respectively to the paneer cheese to check the possibility of consumer acceptability and functionality.

Methods. Cow milk was used for this experiment and fat, and solid non-fat of that milk were analyzed using the Gerber

method and standard equation to find Solid non-fat. To produce quality paneer cheese it is recommended to add 0.08-0.15% of ($CaCl_2$) Calcium chloride into the milk to induce coagulation. Also, such treatment is increasing the final output of paneer. For the purpose of producing paneer cheese, milk was optimized with 4.5% fat standard levels using the Pearson square method of standardization technique at standard heating at 90ºC temperature [7]. Then the milk was cooled down to a coagulation temperature of around 40ºC, and 0.2% of citric acid was added to the milk while agitated the solution manually and gentle stirring was done for 5 minutes. The whey was drained and separated. Coagulum was taken and allowed to settle for 10 minutes.

Whey is the byproduct obtained from paneer cheese making was filtered and drained off by using a cheese cloth. Soft paneer curd was incorporated with Murunga leaf power (0.50, 1.00, 1.50 and 2.00% and 0% control sample). These paneer mix were subjected a pressure (2 kg/cm^2) for 15-20 minutes to have hard paneer [7]. The recommendation for hard paneer making and soft paneer was not subjected to any pressing. The paneer cheese was cut into 3cm^3 cubic sizes for further chemical, microbial and sensory analysis.

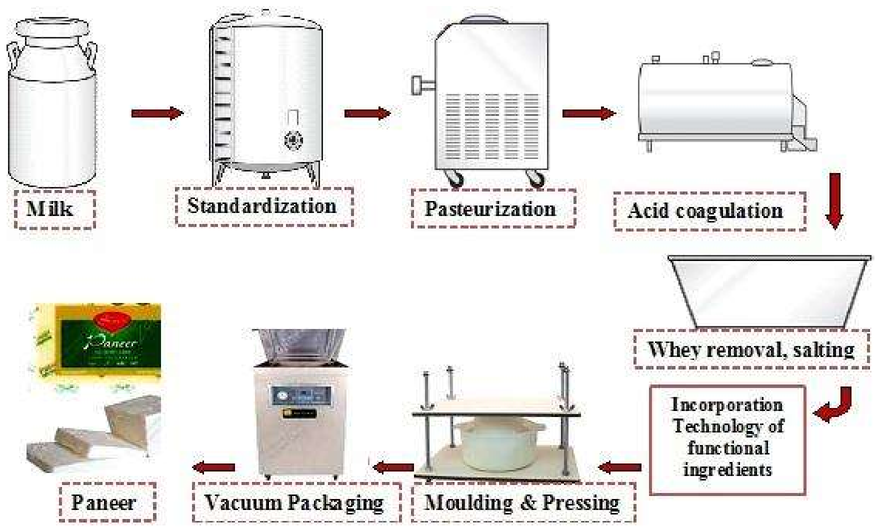

Figure 1. Production flow and technology to incorporate Murunga leaf powder

Each replicate was divided into equal sizes to evaluate sensory, microbial properties and Physico-chemical parameters. Total Coliform Count (TCC) was done by using the Spread plate method, and Total Plate Count (TPC) was done by using the pour plate method as explained in the article [9,10]. Shelf life evaluation was done at an interval of 10 days from the 1st, to the 30th days. Chemical analyses such as titratable acidity, and pH (Model 230A+) [12] were done for the prepared samples and control samples.

The sensory evaluation was conducted to find out the best percentage of Murunga treatment and findout the self-life of 4 treatments and control. A sensory panel of 30 untrained panelists were used for this experiment and color, odour, texture, smell and overall acceptability were evaluated (5 points Hedonic scale) [13]. The non-parametric statistic was conducted by using Minitab software and tested using CRBD -Complete Randomized Block Design.

Table 1

Research plan

Experiment (100 g of Paneer)	Treatments (Murunga leaf powder) (%)				
	Control	**T_1**	**T_2**	**T_3**	**T_4**
Hard Paneer	0g	0.50	1.00	1.50	2.00

Results. The study was conducted to characterize the paneer cheese by analysisng the chemical composition, chemical co of the Murunga-added paneer made with different percentages. The primary analysis of the composition of Murunga powder is shown in Table 2. It is identifiable that Murunga leaf has a high amount of carbohydrates and proteins on a dry matter basis. Also, it contains a lot of minerals and vitamins.

Table 2

Proximate composition (Dry Matter basis) of Murunga leaf powder

Composition (w/w)	Percentage (%)
Carbohydrates	52.26 ± 0.35
Proteins	27.18 ± 0.23
Ash	12.10 ±0.22
Lipids	06.15 ± 0.12

The pH of all Murunga added samples showed a slight decrease and affected significantly ($P \leq 0.05$) with storage while the Titratable acidity of the paneer samples was not affected ($P \geq 0.05$) with storage. The moisture content of the sample was 54.36±3.45 % on day 1 and it was not showing any significant difference with storage or percentage of Murunga leaf powder addition.

Table 3

The chemical composition of the Murunga added hard paneer cheese

Components	Storage period (Days)	Treatment with Murunga leaf powder (in %)				
		Control	**T_1**	**T_2**	**T_3**	**T_4**
Titratable Acidity	Fresh	0.23±0.01	0.24±0.01	0.24±0.02	0.25±0.01	0.26±0.01
	10	0.24±0.01	0.24±0.01	0.24±0.02	0.25±0.01	0.26±0.01
	20	0.24±0.01	0.26±0.01	0.27±0.02	0.27±0.03	0.27±0.04
	30	0.28±0.01	0.27±0.01	0.27±0.02	0.28±0.03	0.28±0.04
pH		6.45±0.03	6.55±0.03	6.56±0.04	6.57±0.05	6.58±0.06
	10	6.32±0.03	6.37±0.02	6.37±0.03	6.38±0.04	6.38±0.05
	20	6.01±0.03	6.11±0.03	6.11±0.04	6.12±0.05	6.12±0.06
	30	5.84±0.02	5.94±0.02	5.94±0.03	5.97±0.04	5.99±0.05

Table 4

Proximate composition of the Murunga added hard paneer cheese

Components	Storage period (Days)	Treatment with Murunga leaf powder (in %)				
		Control	0.50%	1.00%	1.50%	2.00%
Total Solid (%)	Fresh	37.20±2.51	38.11±2.51	38.11±2.52	38.11±2.53	38.11±2.54
	10	37.61±2.30	38.21±2.30	38.22±2.31	38.26±2.32	38.31±2.33
	20	37.63±2.01	38.23±2.01	38.27±2.02	38.29±2.03	38.33±2.04
	30	37.71±4.01	38.42±4.01	38.42±4.02	38.42±4.03	38.62±4.04
Fat (%)	Fresh	12.50±1.02	12.70±1.02	12.70±1.03	12.71±1.04	12.73±1.05
	10	12.61±1.03	12.71±1.03	12.71±1.04	12.71±1.05	12.73±1.06
	20	12.63±1.03	12.72±1.03	12.72±1.04	12.72±1.05	12.74±1.06
	30	12.64±1.03	12.74±1.03	12.74±1.04	12.74±1.05	12.80±1.06
Crude Protein (%)	Fresh	02.08±0.01	02.13±0.01	02.13±0.02	02.14±0.03	02.20±0.04
	10	02.06±0.01	02.11±0.01	02.14±0.02	02.16±0.03	02.21±0.04
	20	02.07±0.03	02.15±0.03	02.14±0.04	02.17±0.05	02.23±0.06
	30	02.10±0.03	02.20±0.03	02.19±0.04	02.19±0.05	02.23±0.06

The crude protein content and fat contents were not showing significant different for all samples including control samples. This indicated that there was no significant effect of Murunga leaf powder on paneer cheese. There was a slight increase in the fat and protein percentage due to the moisture loss and it was not significantly different with storage and percentage of Murunga leaf powder (P≥0.05).

Table 5

Total plate count and total samples

Sample	Fresh		10 days		20 days		30 days	
	Control	Treatment	Control	Treatment	Control	treatment	Control	Treatment
T_1	1.08×10^2	1.07×10^2	1.61×10^2	1.10×10^2	2.61×10^2	1.23×10^2	2.13×10^2	1.81×10^2
T_2	1.08×10^2	1.07×10^2	1.59×10^2	1.09×10^2	2.06×10^2	1.04×10^2	2.26×10^2	1.78×10^2
T_3	1.06×10^2	1.08×10^2	1.57×10^2	1.08×10^2	2.18×10^2	0.93×10^2	2.25×10^2	1.18×10^2
T_4	1.06×10^2	1.08×10^2	1.56×10^2	1.08×10^2	2.07×10^2	1.01×10^2	2.15×10^2	1.80×10^2

During the storage, TPC of the samples was increased and some of the selected treatments were having slight increase in TPC at a decreasing rate. Therefore, Murunga leaf powder added samples have moderate effect on the reduction of microbes.

Table 6

Sensory evaluation sum of ranks for texture, odour and overall acceptance

Sensory Attribute	Control sample	T_1 Sample	T_2 sample	T_3 sample	T_4% sample
Color	53	66	54	75	75
Odor	60	76	63	58	49
Texture	66	71	63	79	76
Flavor	69	70	63	79	62
Overall acceptability	69	63	69	75	68

Disscussions. Citric acid was used for this study as per suggestion by [16] and found that coagulant has many effects on the prepared paneer cheese body and texture. A low level of acidic strength resulted in a smooth texture and soft texture of the body, while the high acidic strength resulted in a very hard body in the paneer. The paneer produced with curd yielded a smooth texture and a very soft texture because it is having lower acidic curd strength. The paneer cheese which was coagulated by citric acid showed a nearly a hard texture because of high acidic strength of citric acid. Chemical analysis of paneer samples were carried out by the method mentioned in the previous research articles [13]. The chemical composition of the Muringa-added hard paneer cheese is shown in Table 3.

Murunga leaf powder added to paneer was having consistency in protein and fat content. Also, the pieces of leaves provided nice color and appearance to the product. It increased consumer acceptance. They incorporate antioxidants compounds in to the food the improve 14]. Therefore, it is widely used in paneer to improve functionality.

Heat treatment especially pasteurization of milk destruct the microbes that denatures proteins available there and retards the solubility of colloidal form of calcium phosphate [4]. Total plate counts (TPC) and molds counts were tested and it was identified that TPC was having a significant difference with the control and the treatments ($P \le 0.05$) and it increased drastically after 20 days of storage hence still it was recommended for consumption for 30 days.

It showed that Murunga leaf has a significant level of ($P \le 0.05$) inhibitory effect on the bacteria. The molds were not observed throughout the experiments till 20th day but there was a mold growth observed on the 30th day. Also, it showed that Murunga leaf has a significant inhibitory effect on mold. It may be due to the hygienic conditions and the in-place cleaning mechanism maintained throughout the processing [15, 16].

Escherichia coli O157:H7 is recognized as a very important pathogen available [17]. Pathogens in food industry such as *E. coli* O157:H7 can survive in the acidic conditions and they can cause infections [18]. Studies about the Murunga leaves and its extracts revealed that the antimicrobial potential are available there and it inhibited the growth of 8 pathogenic bacteria such as *Streptococcus pyogenes, Escherichia coli, Staphylococcus aureus, Streptococcus agalactiae, Bacillus subtilis, Staphylococcus epidermis, Salmonella senftenberg*, and fungi such as *Candida albicans*). This suggests that the pharmaceutical industries and food processing industries can incorporate Murunga leaves and its extracts as a antimicrobial agent [19].

The sensory attributes that influence the acceptability of Murunga leaf powder added paneer such as color, odour, texture, flavour and overall acceptability are shown in Table 6. T_1 (0.50% Murunga leaf powder) showed the lowest level of overall acceptability score. The curd was pressed by using a spoon to evaluate the springiness and hardness [20]. Also, the T_4 sample showed a drastic increase in microbial count, the lowest level in odour and flavor. Murunga leaf has some essential oils which give more functional properties to paneer. Hexacosane, pentacosane and heptacosane are the essential oils found in the Murunga leaf extracts helps to improve the properties of paneer [22, 23].

However, overall acceptability and textural improvement were observed in T_3 sample which was significantly different ($P \le 0.05$) and having the highest score for texture shown in figure 02. The analysis showed that the odour and overall acceptability of T_3 (1.50%

Murunga leaf powder) added sample showed the highest level of a score but a lower score for odour.

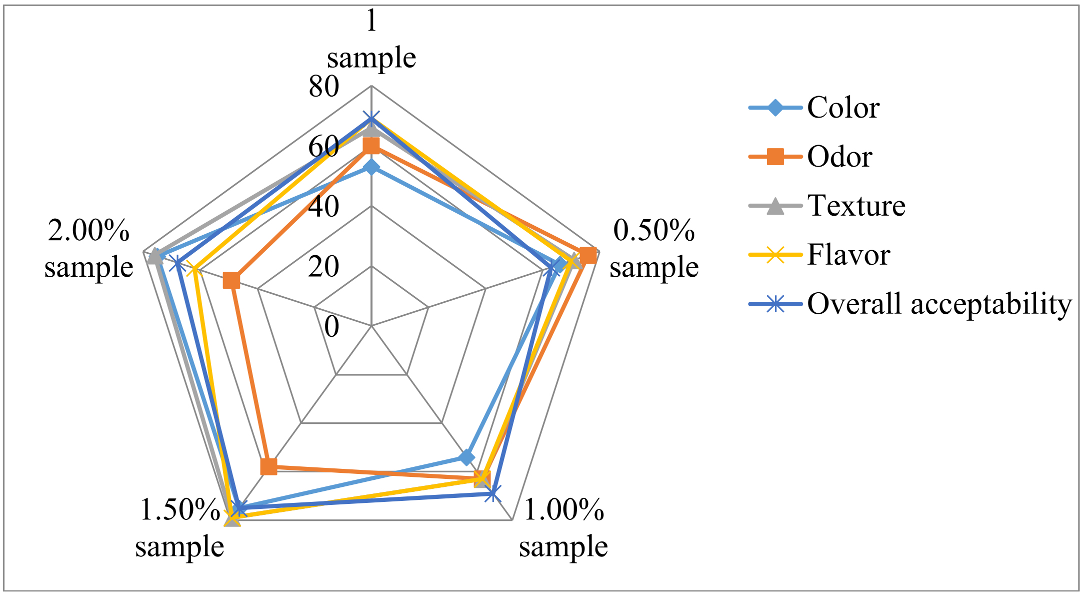

Figure 2. Sum of rank for Murunga leaf powder added sample and control sample

Figure 2 showed that the organoleptic properties of samples were having significant differences in color due to the natural pigments available in the Murunga leaf. Also, Murunga leaf powder is having some ability or compounds that may alter some attributes such as flavor, color, odor, appearance and overall acceptability. The juice produced from Murunga leaf has an antimicrobial agent and that inhibits the microorganisms such as *Staphylococcus aureus and Pseudomonas aeruginosa* [24]. The TPC of this study expressed a significant reduction of microbes Murunga leaf powder incorporated food compared to control with the storage time. It means the Spoilage of the Murunga leaf powder incorporated foods were slower than untreated samples.

Conclusion. Dehydrated Murunga leaf powder added to paneer has high acceptability especially T_3 is identified as the best percentage. Also, it has effects on increasing the shelf life of paneer due to the inhibitory effect against microorganisms. Therefore, Murunga leaf powder could be used as preservative agent in production of dairy products. Murunga leaf powder (1.5%) could be considered the acceptable amount for paneer cheese production.

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UDK 664.34:637.144

INDICATORS OF BLENDING OF REFINED VEGETABLE OILS

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Abstract:

Objective. This article discusses the issues of blending refined vegetable oils and the impact on fatty acid composition. The effect on its physicochemical properties has been studied.

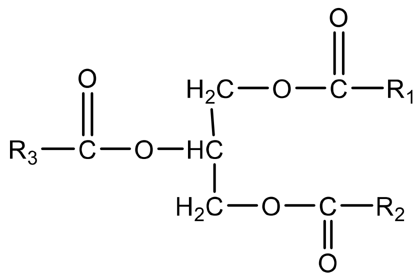
Methods. The fatty acid composition was determined on an Agilent 8860 GC gas chromatograph with a flame ionization detector using a Supelco 100m x 0.25mm capillary column with SRtm-2560 phase, helium carrier gas, column programming temperature from 1400 C to 2500 C. The acid number and peroxide number were determined according to GOST standards.

Results. It has been established that biologically valuable components are higher in unrefined oil than in refined oil. The physicochemical composition of the resulting mixtures was studied, and it was found that they correspond to the normative technical documentation.

Conclusion. Thus, based on the study of blending refined vegetable oils at different ratios (as well as unrefined), the ratio of ω-6:ω-3 is different.

Keywords: Vegetable oil, fatty acid composition, physico-chemical composition, peroxide number, acid number, biological value.

Introduction. Fats and oils, in terms of organic chemistry [1-8], are described as esters of glycerol and fatty acids, called glycerides or triglycerides. These compounds consist of glycerol linked to three molecules of fatty acids, where the hydrocarbon residues of higher carboxylic acids are R_1, R_2 and R_3.



Vegetable oils and products play an essential role in human nutrition, providing the necessary calorie content and the content of biologically active substances of a lipid nature, including essential ones. Nutritionists recommend adding products with a balanced fatty acid composition to the human diet, including polyunsaturated fatty acids of the omega-3 and omega-6 families in an optimal ratio of 1: (5-10), as well as biologically active substances such as vitamins, provitamins and phytosterols. Products containing oil oxidation products and trans-fatty acids should be avoided [1,2].

In the world, with an increase in the production of vegetable oils and the creation of new types of oil and fat products for various sectors of the economy, as well as taking into account recommendations for their composition, it is becoming increasingly important to ensure the high quality and safety of the original vegetable oils, as well as the constant improvement of technologies for their modification. Therefore, it is necessary to develop new methods and technologies to improve the quality and safety of vegetable oils.

Research methodology. The fatty acid composition was determined on an Agilent 8860 GC gas chromatograph with a flame ionization detector using a Supelco 100m x 0.25mm capillary column with SRtm-2560 phase, helium carrier gas, column programming temperature from 1400 C to 2500 C. The acid number and peroxide number were determined according to GOST standards [9-12].

Results and discussion. In works [13-17] blending of unrefined vegetable oils was carried out, where a balanced mixture of vegetable oils was obtained for daily, medicinal and prophylactic purposes. Vegetable oils were blended at the same ratios to study the effect of the refining process on these compositions.

№1. Cottonseed oil + linseed oil + rapeseed oil - 70:10:20;

№2. Soybean oil + sunflower oil - 60:40;

№3. Rapeseed oil + sunflower oil - 20:80;

№4. Rapeseed oil + sunflower oil - 10:90;

№5. Cottonseed oil + linseed oil - 80: 20;

№6. Cottonseed oil + soybean oil - 60:40;

№7. Cottonseed oil + soybean oil + rapeseed oil - 60:30:10;

Further, the fatty acid composition of the above-mixed vegetable oils was studied on a modern Agilent Technologies 6890 N gas-liquid chromatograph with a flame ionization detector. The results are shown in the table. 1.

Table 1

Composition of fatty acids of blended mixtures of refined vegetable oils

Fatty acids	№1 (cot.+ lin. + rape.)	№2 (soy. + sun.)	№3 (rape.+ sun.)
Lauric, 12:0	Сл.	-	-
Myristic, 14:0	0,54	0,06	0,15
Palmitic, 16:0	15,7	7,98	7,36
Palmitoleic, 16:1	0,36	0,06	0,10
Margaric, 17:0	0,08	0,07	-
Stearic, 18:0	2,35	3,54	2,88
Oleic, 18:1	19,21	22,93	16,89
Linoleic, 18:2 **ω-6**	42,8	59,83	61,84
Linolenic, 18:3 **ω-3**	10,8	4,33	3,78
Arachidonic, 20:0	0,33	0,35	0,37
Eicosenoic, 20:1	2,91	0,18	1,58
Behenic, 22:0	0,31	0,50	0,72
Erucic, 22:1	4,23	-	3,88
Lignoceric, 24:0	0,16	0,17	0,25
Nervonic, 24:1	0,21	-	0,20
$\Sigma_{\text{saturated FA}}$	19,5	12,67	11,73
$\Sigma_{\text{unsaturated FA}}$	80,5	87,33	88,27

Table 2

Composition of fatty acids of blended mixtures of refined vegetable oils

Fatty acids	№4 (rape.+ sun.)	№5 (cot.+ lin.)	№6 (cot.+ soy.)	№7 (cot.+ soy.+ rape.)
Myristic, 14:0	0,06	0,60	0,46	0,47
Palmitic, 16:0	4,69	17,4	17,37	16,6
Palmitoleic, 16:1	0,08	0,40	0,35	0,31
Margaric, 17:0	0,05	tr.	tr.	-
Stearic, 18:0	3,13	2,65	3,37	3,06
Oleic, 18:1	15,47	18,86	22,27	21,83
Linoleic, 18:2 **ω-6**	69,1	46,3	52,25	49,26
Linolenic, 18:3 **ω-3**	2,08	13,3	3,2	3,66
Arachidonic, 20:0	0,32	0,23	0,30	0,35
Eicosenoic, 20:1	1,65	0,05	0,12	1,64
Behenic, 22:0	0,73	0,12	0,21	0,29
Erucic, 22:1	2,30	-	-	2,27
Lignoceric, 24:0	0,22	0,07	0,10	0,15
Nervonic, 24:1	0,12	-	-	0,11
$\Sigma_{\text{saturated FA}}$	9,2	21,1	21,81	20,92
$\Sigma_{\text{unsaturated FA}}$	90,8	78,9	78,19	79,08

From the data obtained in Table 1 and 2, it can be seen that, with the blending of refined vegetable oils, the ratio ω-6:ω-3 is:

№1. Cottonseed oil + linseed oil + rapeseed oil - ω-6:ω-3 - 4:1;

№2. Soybean oil + sunflower oil - ω-6:ω-3 - 14:1;

№3. Rapeseed oil + sunflower oil - ω-6:ω-3 - 16:1;

№4. Rapeseed oil + sunflower oil - ω-6:ω-3 - 33:1;

№5. Cottonseed oil + linseed oil - ω-6:ω-3 - 3.4:1;

№6. Cottonseed oil + soybean oil - ω-6:ω-3 - 16:1;

№7. Cottonseed oil + soybean oil + rapeseed oil - ω-6:ω-3 - 13.1:1;

The ratio ω-6:ω-3 in more than one sample does not meet the requirements set by nutritionists and nutritionists [13]. According to him, for a healthy person, it should be ω-6: ω-3-10: 1; for therapeutic

and preventive nutrition, ω-6:ω-3-5:1 or 3:1.

In works [13-17], unrefined vegetable oils were studied at the same ratios. We compare them with the results of refined oils (Tables 1 and 2). The refined oils ratio no longer corresponds to the required ones. Further, the change in the acid and peroxide values of the original and blended vegetable oils was studied (Tables 3-4).

Table 3

Fundamental data on refined vegetable oils

Indicator name	Vegetable oils				
	rapeseed	sunflower	cottonseed	soybean	linseed
Acid number (mg KOH/g)	0,3	0,2	0,3	0,2	0,4
Peroxide value (mmol O_2 /kg)	2,1	1,8	3,2	1,9	2,5

Table 4

Changes in acid and peroxide values of blended vegetable oils

Name of product	Acid number (mg KOH/g)	Peroxide value (mmol O_2 /kg)
№1 (cot.+ lin. + rape.)	0,3	2,8
№2 (soy. + sun.)	0,2	1,9
№3 (rape.+ sun.)	0,2	1,8
№4 (rape.+ sun.)	0,2	1,8
№5 (cot.+ lin.)	0,3	3,1
№6 (cot.+ soy.)	0,2	2,6
№7 (cot.+ soy.+ rape.)	0,2	2,7

As can be seen from the data obtained in Table. 3-4 you can see that all the physicochemical parameters of the original and blended refined vegetable oils correspond to the normative technical documentation.

Conclusion. Thus, based on the study of blending refined vegetable oils at different ratios (and unrefined), the ω-6:ω-3 ratio is different. This can be explained by the fact that valuable fatty acids are partially lost during refining, and therefore the ratios made from unrefined oils need to be changed. For example: in samples No. 1 and No. 5, they need to increase the amount of linseed oil, or in samples No. 2,3,6, they need to reduce the amount of ω-6.

It has been established that biologically valuable components of unrefined oil are higher than those of refined oil. Further research will look to obtain a balanced cooking PUFA for daily consumption.

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CHOOSING ACCEPTABLE PARAMETERS FOR EXPERIMENT ON NEW ENERGY-SAVING VACUUM SUBLIMATION DRYING EQUIPMENT

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Abstract:

Objective. The purpose of the project was to increase the capacity of our country on fruit and vegetable expositions, to research drying devices in order to increase their economic efficiency by reducing the energy consumption of existing devices, to create a new energy-saving vacuum sublimation drying device and to improve the technological process regimes.

Methods. In carrying out the study, methods of collecting data on the subject, studying national and foreign experience, systematic analysis of literature, generalization and recording of practical results were used.

Results. In this article, the optimal parameters for experimenting with a new energy-efficient, improved vacuum sublimation drying equipment developed by researchers are reflected.

Conclusion. The analysis of the data obtained shows that the total energy and operational costs in the sublimation drying method are higher than in other drying methods (except for dielectric drying). Therefore, this method of drying is used for drying materials (meat, fruits, vegetables, medicine and pharmaceutical products), which are valuable substances, resistant to high temperatures and whose biological properties must be preserved for a long period of time. But in this process, the product retains almost 98% of vitamins in itself, and its appearance practically does not change.

Keywords. Vacuum, sublimation, energy saving, freezing, drying chamber, pump, barometer.

Introduction. Today, the requirements for the cultivation of agricultural products, their processing, the production and safety of quality food products are increasing year by year. In order to meet the country's ever-increasing demand for high-quality food products, it is necessary to create modern technological processes with high efficiency and automated management, which ensure obtaining high-quality products [1]. Drying is the most energy-consuming, complex physico-chemical and technological process in which heat and matter exchange states are interrelated. The main thing in drying products is to preserve their properties and increase their quality. Sublimation drying is the only viable method for obtaining dry form for most thermolabile biological materials. The reason is that in this case the quality of the product is maximum, it is easily regenerated when it is moistened, and the initial properties of the dried product such as smell, taste, color, nutritional and biological value are preserved [2].

Methods. In carrying out the study, methods of collecting data on the subject, studying national and foreign experience, systematic analysis of literature, generalization and recording of practical results were used.

Discussions. Sublimation is the process by which a substance changes from a solid state to a liquid state directly to a gas (or vapor) state. The process of dehydrating materials under high vacuum while freezing is known as sublimation drying. In such conditions, the moisture contained in the material is in the form of ice, and then this ice turns directly into vapor without changing to a liquid state. Sublimation drying as a technological process includes the following stages: material preparation, freezing, placing in a sublimation chamber, sublimation drying and packaging.

The first stage is preparation of fruits for drying. Before drying, it is necessary to pay attention to the fact that the fruits are not overripe, there are no worms, there are not many defects and they are in a clean state.

The second stage - the Subkhan variety apricot selected as a research object was placed on dryer sheets and -40^0C frozen to room temperature in a laboratory freezer called Arctico. The process depends on the ambient temperature and lasts up to 8 hours. If the external environment is above 25^0 C, the freezing rate will be lower.

The task

It is designed for freezing all kinds of agricultural products, fruit and vegetable products.

Model

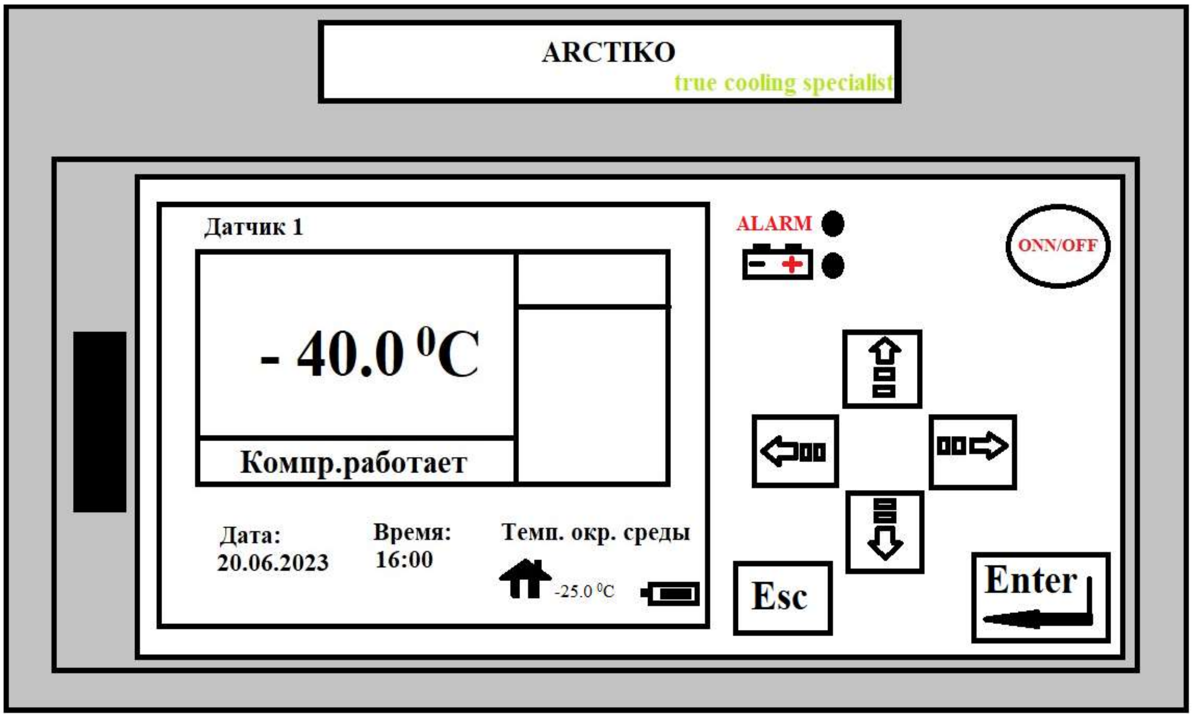
LAF 700

1.1 - picture

Technical classification

No	**Indicators**	
1	Style	Arctiko
2	Country of manufacture of the device	Germany
3	Cooling technology	The air is forced
4	Temperature range (^{0}C)	-10 / -40
5	Electricity consumption (Volts)	230
6	Maximum ambient temperature (^{0}C)	25
7	Capacity (Liter)	618
8	External dimensions WxDxH (mm)	740x870x2017
9	Internal dimensions WxDxH (mm)	600x685x1505
10	Power (Watt)	735
11	Mass (kg)	138

After placing the product in the freezing chamber, it was started in the following order:



1.2 - picture . Refrigerator control panel

a) ON / OFF button is pressed;
b) the password is typed;
c) enter button is pressed.

After the product is sufficiently frozen, the freezing chamber is turned off in the same way.

The third stage - the product was removed from the freezing chamber and placed in the drying chamber, and the temperature inside the chamber $-30^0\mathrm{C}$ was adjusted. To bring the temperature inside the chamber to negative level, the freezing knob on the electroplate was turned and the indicator reading was brought to 30 and the temperature was raised according to the table below.

1.1 - table

No	time (hours)	chamber temperature (^{0}C)	Vacuum (kPa)
1	4	-30	0.1
2	4	-20	0.1
3	4	-10	0.1
4	4	-5	0.1
5	4	0	0.1
6	4	5	0.1
7	4	10	0.1
8	4	20	0.1
9	4	30	0.1
10	12	35	0.1

It can be seen that after placing the product in the drying chamber, the temperature inside the chamber was brought to a positive (+) level for a certain period of time. In this case, the sequence of the process goes as follows:

a) the chamber freezing system is turned off;

b) I turned on the water pump;

c) I turned on the heater;

g) I brought the indicator to the required amount.

I raised the temperature according to the plan.

After the drying process of the product is completed, the procedure for turning off the dryer is:

a) closing the hose where water enters the pump;

b) I slowly introduced air through the screw on the top of the chamber until the barometer reading passed 15:00 clockwise;

c) I turned off the pump.

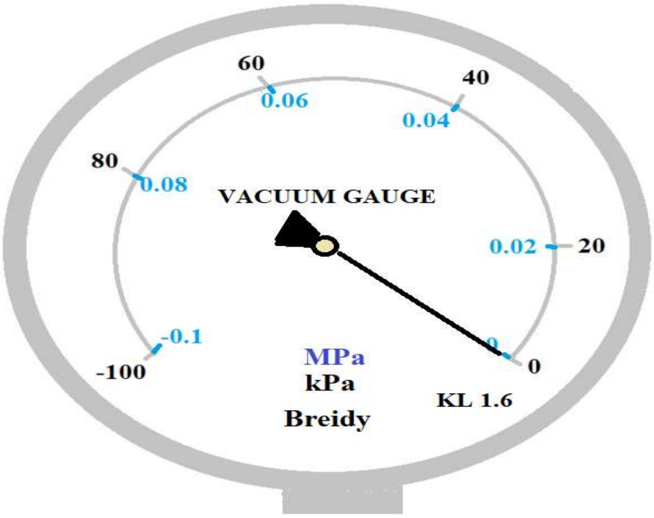


Figure 1.3. Vacuum gauge

Summary. Sublimation drying of fruits and vegetables has higher overall energy and operating costs than other drying methods (except dielectric drying). Therefore, this drying method is used for drying valuable substances, materials resistant to high temperatures and whose biological properties must be preserved for a long time (meat, fruit, vegetables, medical and pharmaceutical products). When products are dried in this way, their parameters such as taste, appearance, smell, size and nutritional content remain almost unchanged.

During the experiment, it was reflected that the drying of food products by sublimation method has a number of advantages:

- useful properties of products are almost completely preserved;
- product weight kama yadi, it is convenient to transport products;
- it is not necessary to store in the refrigerator, after freeze-drying, the products can be stored for a long time without refrigeration;
- the product sale is carried out under favorable conditions will increase. Even in retail outlets that do not have refrigerators, products can be sold due to the possibility of non-refrigerated storage.

It is possible to save product features.

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DETERMINING THE EFFECTIVENESS OF SOAKING ALMOND KERNELS BEFORE PROCESSING

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Abstract:

Objective. As the object of this research work, samples of almonds soaked at different times were selected, and the influence of the time of thawing of kernels on the nutritional value, quality, product characteristics, shelf life and organoleptic characteristics of plant milk was studied.

Method. Plant milks were obtained in laboratory conditions from selected and thawed samples with a difference of 2 hours. The received milks were compared with Lactoscan S analytical equipment and organoleptic characteristics based on GOST requirements.

Results. The results of the experiment were compared with the differences in the cooling times between the samples. The results are presented in the relevant tables and discussed.

Conclusion. According to the results of the research work, it was proved that unsoaked almond kernels are superior to frozen samples. In addition, taking into account that freezing cores requires excessive resources and technological processes, it is recommended not to freeze cores before technological processing.

Keywords: almond kernel, soaking, alternative milk, vegetarian lifestyle, cholesterol, almond shell, lactoscan S.

Introduction. Almond milk is the oldest and widely consumed alternative milk among plant milks. Almonds have become an important food for a modern healthy lifestyle because they contain many useful components [1]. The first patented (USA 5656321A) technology for the industrial production of almond milk proposes the slow treatment at 90 °C of an aqueous dispersion of partially processed defatted ground almonds with a ratio of 8 ± 1% and about 0.1% stabilizing hydrocolloid. This process serves to ensure the solubility of compounds in the emulsion. It is then ground in water and spun in a centrifuge. Then the product is sterilized at high temperature using "UHT" and the homogenized product is aseptically packaged during cooling. [2].

In the above studies, roasting or not roasting raw almonds in the production of almond milk has an effect on the amount of phytosterols in almond milk. For example, it can be seen that the amount of β-sitosterol-β-D-glucoside in roasted almond milk is 78 mg/100 ml, and in unroasted almond milk it is 13 mg/100 ml. Another aspect is that the stigmasterol concentration in roasted almond kernel milk is less than 0.03 mg/100 ml, while unroasted almond kernel milk contains 1.9 mg/100 ml of stigmasterol. Such differences of bioactive compounds in one type of plant milk represent the effect of

processing and technological processes of raw materials of plant milk.

Almond milk is a protein-rich type of nut-based raw material. Almonds contain an average of 25% protein and contain unique amino acids. Compared to other vegetable milk raw materials, milk made from almonds is very rich in vitamins. It is rich in vitamin E and is found in the form of manganese and alpha-tocopherol. Alpha-tocopherol is also considered a very powerful antioxidant. In addition, almonds are rich in important trace elements such as calcium, potassium, magnesium, selenium, zinc, copper and phosphorus. [3].

Almonds are a rich source of calcium and healthy fatty acids, while being lower in calories, making them nutritionally healthier than other plant-based milks. Because almonds are a nut, they can cause allergies in some people and their high price limits their popularity as a drink.

The yield of almonds is on average 0.7-1.2 t/ha, and the productivity is 2-2.5 t/hectare in highly irrigated lands. Almonds begin to harvest from the age of 3-4 and give a good harvest from the age of 12-18 to 35-40 years. With good care, it can produce 60-100 years. The yield of one bush is from 3-4 kg to 10-20 kg, even 30-40 kg. It is possible to establish almond orchards on very large areas in mountainous and semi-arid areas of our republic. The following varieties are included in the State Register for planting in the territory of Uzbekistan: "Bostonliq kechpishari", "Konsoy", "Qilichnuskha", "Tong'ich" (Pervenes), "Tian-Shan", "Guzal" (Krasivy). , local varieties such as "Ertapishar" (Ranni), "Ugom" and imported "Krim", "Nikita kechpishari", "Primer", "Nikita-62", "Yalta" (Russia), "Turkman excellence" (Turkmenistan), "Nonparel" (France), "Drake" (USA) and others are among them [4]

Nuts such as almonds, walnuts and some cereals contain more unsaturated fatty acids than saturated fatty acids. Naturally, these fatty acids are preserved in all plant-based milks, except for coconut and johori cereal. The main saturated fatty acids found in plant-based milk alternatives are stearic, oleic and linoleic acids [5],[6],[7].

Methods. A local variety of sweet almond growing in natural conditions created by selection on the basis of ancient (Amygdalus communis L.) ancestors in Uzbekistan was selected as a research object. 5 samples of the same amount were taken from the selected almond kernels, and each one was soaked in filtered water with a difference of 2 hours. Milk was taken from the samples in laboratory conditions, homogenized with the addition of an emulsifier, and comparative analyzes were carried out on the Lactoscan S analytical equipment.

Analyzes were carried out on the basis of the concentrate standards of the equipment. Also, the obtained samples were kept for 10 days to study the storability and changes in organoleptic properties over time. In the organoleptic assessment, the appearance, taste, smell and general consistency of almond milk were studied based on the recommendations required by the GOST 29245-91 standard. According to the recommendations of this standard, the organoleptic parameters of milk should be evaluated depending on the consumption method of this product. The temperature of the analyzed milk samples is required to be around 20°C.[1]

To assess the appearance or color of plant milk, it was determined by pouring it into a transparent container in natural light; in order to evaluate its smell, plant milk is cooled in a cleaned closed container, shaken again and smelled from the mouth

[1] ГОСТ 29245-91 Консервы молочные. Методы определения физических и органолептических показателей.

of the container; when determining the taste, milk in a cleaned container is evaluated by shaking it well and drinking it; consistency of plant milk is determined by pouring milk from one transparent container to another. Attention is also paid to how much milk is divided into phases during storage.

Results. Almond milk of all sample types was subjected to the same technological process under the same conditions and quantities. Before technological processing, they consisted of one sample that was not frozen and samples that were frozen for 2, 4, 6, 8 hours. Tajriba ishi yakunlangach namunalar sut tarkibini aniqlovchi Lactoscan S qurilmasida qiyosiy tahlil qilindi. Ushbu tahlillarning natijasi bilan 1-jadvalda tanishish mumkin.

Table 1

Results of the comparative analysis conducted in Lactoscan S

№	Soaking time, h	Fats, %	Carbohydrates, %	Proteins %	Density	Dry Matter, %
1	0	06.59	01.89	01.21	05.52	03.46
2	2	06.28	01.78	01.13	05.10	03.25
3	4	06.37	01.53	00.98	03.34	02.82
4	6	07.06	01.65	01.05	03.34	03.04
5	8	07.72	01.85	01.18	03.99	03.41

The samples were stored for 10 days to conduct organoleptic analyzes of the experiment, the purpose of which was to analyze the variability of the phase composition and other organoleptic properties of the sample during storage. These analyzes were studied on the basis of criteria corresponding to the organoleptic evaluation of milk and milk products specified in GOST requirements. To determine the orgonoleptic evaluations of the tested samples, the samples were taken out of the freezer and studied after they were brought to the required temperature for 30 minutes. Comparative results of organoleptic analyzes are presented in Table 2.

Table 2

Organoleptic indicators of almond-based milk samples after 10 days of storage

Samples	Soaking time, h	Taste	Smell	Colour	Consistency
1	0	Like almond, pleasant	Typical almond	Creamy	Homogeneous, without sedimentation
2	2	Wooden	Typical almond	Creamy	Homogeneous, more liquid, without precipitation
3	4	Wooden	Typical nut	White	Two-phase, thick
4	6	Rusty	Typical nut, Pungent smell	Yellowish white	Three-phase, has sedimentation
5	**8**	Like humid	Pungent smell	Yellowish	Divided into three phases

Discussions. If we compare the results, it can be said that the milk sample made from unheated almond kernel of the 1st sample is more effective than the others. In the analyzes determined by the Lactoscan S device, it can be observed that the amount of fat in the 8th sample was more. It can be said that this is due to the swelling of the fat globules in the endosperm when the kernels are cooled for a long time and they release more mass during crushing. Dry matter also had a greater contribution in the 8th sample. This also indicates a preference for sample 8, but the protein, carbohydrate, and density increases disproportionately toward the unheated sample.

In addition, taking into account that the heating of kernels requires excessive resources and time in the technological process, and considering that there is almost no significant difference between the fat content of sample 8 and the fat content of sample 1, the non-heated sample can be said to be more important. In our previous experiments, it was proved that there are technologically unfavorable features in the skin of almond kernels that can spoil the quality of milk. The more the almond kernels are frozen, the more substances in the kernel skin are released into the milk mass.

It can also be seen from the organoleptic evaluations that the 8th sample was divided into more phases during the storage process, and its color, smell and taste underwent more changes. The consistency of the milk made from crushed almond kernels without cooling is well preserved, the characteristic color of milk, the characteristic taste and smell of almond milk are more preserved. More importantly, negative changes in organoleptic characteristics were noted with increasing freezing time. Samples taken from unheated almond kernels have maintained a homogeneous consistency for a long time, there have been no changes in color, and they can be an alternative to dairy milk in terms of smell and taste.

Conclusion. Alternative milks based on almond kernels can compete with cow's milk in terms of organoleptic indicators and shelf life if properly processed.

In addition, almond milk does not contain lactose, and various vitamins and useful components are more common. According to the general conclusion of two types of analysis, unfrozen almond kernels proved to be a priority sample with quality, nutrition, marketability, less time required in the technological process and less resource consumption.

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CHEMICAL TECHNOLOGIES

UDC 678

ADHESION OF A THERMOREACTIVE EPOXY WATERFUL EMULSION FILM FORMER ON METAL

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Abstract:

Objective. The purpose of this study is to study the adhesive properties of samples of an aqueous emulsion of an epoxy thermosetting polymer, as well as to conduct comparative analyzes of the results of tests performed on water-emulsion epoxy thermosetting film-forming materials to determine adhesive strength. The influence of the concentration of the dry residue of the emulsion system on its adhesive strength is shown.

Methods. To achieve the goal of this study, a method was used to determine the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting polymer on a computerized electromechanical universal testing machine. As an emulsifier in a water-emulsion system based on an epoxy polymer, carboxymethyl cellulose was used in amounts based on the weight of the epoxy resin. To accelerate the hardening of the water-based epoxy film former, the curing accelerator UP-606 was used in the amount of 1.2% by weight of the epoxy resin.

Results. The results of experiments on a computerized electromechanical universal testing machine to determine the adhesive properties of samples of an aqueous emulsion of an epoxy thermosetting film former showed that the highest adhesive strength of the hardened coating of an aqueous epoxy polymer emulsion on metal reaches up to 7.83 MPa at a dry residue concentration of the emulsion system of 60 percent.

Conclusion. The results obtained by the method for determining the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting film former on a computerized electromechanical universal testing machine indicate that this water-emulsion composition based on epoxy resin can be used as a film former, or as a paint and varnish matrix for metals.

Keywords. Anti-corrosion coating, water-based emulsions, epoxy resin, thermoset polymers, adhesive strength.

Introduction. In traditional paints and varnishes, about 50% by weight of the material are organic solvents, which are irretrievably lost during the production of coatings. The toxicity of most of them and the fire and explosion hazard necessitate the installation of powerful ventilation systems in paint shops and additional installations for cleaning gas emissions into the environment. One of the ways to solve the problem of excluding organic solvents from formulations of paints and varnishes is the creation of aqueous film-forming systems [1].

Water-based paints and varnishes can be divided into two groups: water-dispersion film-forming systems, which are an emulsion of the film-forming agent in

water, and water-soluble film-forming systems, which are an aqueous solution of the film former. Water-based paints and varnishes of both types have a relatively high surface tension, which dictates the need for special preparation of the metal for painting to ensure uniformity of the coating and its good adhesion [2].

Reactoplast polymers form a stitched, branched polymer network as a result of cross-condensation or migration polymerization of low molecular weight resins. The resulting polymer is thermoreactive because it has a three-dimensional branched molecular structure. Therefore, in any case, in order to obtain new polymer materials that can exhibit high physical and mechanical properties, it is necessary to correctly choose the conditions of the reaction of combining oligomers with reactive active groups with each other [3]. Some literature sources explain the need to control the stoichiometric proportions of the mixture of oligomers with reactive active groups and the effect of catalysts and initiators used in the production of bicomponent polymer systems. It is very important to optimize the properties of polymer composite materials. The study of optimal stoichiometric ratios guarantees the improvement of the physico-chemical and mechanical properties of the final product [4; 5].

In recent years, the activation of the polymer industry in the fields of chemistry and technology and the need for new materials in the national economy have caused a several-fold increase in the requirements for polymer materials. In this sense, polymer materials are increasingly taking the place of traditional materials such as metal, wood, glass, etc. Plastics are materials that are light, flexible, easy to process, resistant to chemical effects, economically cheap and technologically, they can be used in many directions, and in many cases they are the death of traditional materials. can replace and even exhibit significantly better properties than theirs. The fact that all plastic mass-based materials can be used in various fields of industry, their specific thermal properties, technological parameters in processing or the ease of processing methods, the fact that the part obtained has clearly visible physical and mechanical dimensions make them in engineering technologies. is important in application [6; 7].

Reactoplast polymers are organic polymers that have a network-like molecular structure, and therefore do not soften and liquefy under the influence of temperature, or do not dissolve in any chemical substance. Their thermomechanical properties differ sharply from those of thermoplastic polymers, because at high temperatures, thermoset polymers soften like thermoplastic polymers and, instead of being diluted, go into a highly elastic state at high temperatures after the glass transition temperature. Continued increase in temperature causes further increase of elasticity property, and then destruction of the material due to temperature effect occurs [8]. Materials based on thermoreactive polymers or polymer composites are obtained with high density, solid, resistant to aggressive environments, resistant to various aggressive gases and vapors of aggressive substances. Therefore, they are very convenient to use to protect all types of surfaces. However, in terms of elasticity and impact resistance, it exhibits lower performance than most thermoplastic polymers. But the ability of thermoreactive oligomers to form polyblends with other oligomers and any organic and inorganic fibrillar materials allows to obtain new structural and industrial materials with excellent mechanical and physicochemical properties. Such properties of thermoreactive polymers further expand their field of application [9].

Researchers of the Tashkent Research Institute of Chemical Technology studied the formation of a gel fraction of an

epoxy polymer, which is in the form of a dispersed phase in an aqueous medium. Studies have been carried out on the effect of the accelerator for curing epoxy polymers UP-606 on the duration of hardening of the epoxy film former of water-based paint. It was found that the formation of a coating from an aqueous emulsion of epoxy resin occurs as a result of its coagulation on a substrate. According to the conducted studies, the change in the duration of hardening of the epoxy film-forming agent on an aqueous emulsion was determined depending on the amount of curing accelerator added. The water emulsion epoxy cured at 293 degrees Kelvin. To determine the effect of the accelerator for curing epoxy polymers UP-606 on the duration of curing, the maximum degree of hardening of the epoxy film-forming agent was conditionally accepted. This cure rate was 87% of the gel fraction in the cured epoxy film former. The Soxhlet method was used to determine the content of the gel fraction in the polymer [10].

As a result of the literary analyzes and laboratory studies carried out on the basis of the Tashkent Scientific Research Institute of Chemical Technology, a method was developed for obtaining a water-emulsion-type film former based on epoxy resin. The method for obtaining an epoxy phase emulsion in an aqueous medium is based on the emulsification of epoxy oligomer molecules with carboxymethylcellulose.

Methods. To achieve the goal of this study, a method was used to determine the adhesive strength of samples of an aqueous emulsion of an epoxy thermosetting polymer on a computerized electromechanical universal testing machine. Carboxymethylcellulose was used as an emulsifier in a water-emulsion system based on an epoxy polymer. To accelerate the hardening of the water-based epoxy film former, the curing accelerator UP-606 was used in the amount of 1.2% by weight of the epoxy resin. Table 1 shows the composition of the prepared samples of aqueous emulsion of epoxy resin.

Samples of the epoxy-water emulsion system were prepared in the laboratory as follows: a 200 ml glass beaker was placed in a water bath. Epoxy resin is added to the beaker in the amount depending on the composition shown in Table 1. Next, the heating of the water bath is turned on and the thermostat is adjusted to 45 °C. After the temperature of the resin, the resin equalizes with the temperature of the water bath, the stirrer is lowered into the beaker. The stirrer speed should be in the range of 60-80 rpm.

Table 1

Composition of samples of epoxy aqueous emulsion

Sample numbers	Mass fraction of epoxy resin in the emulsion system, %	Emulsifier concentration by weight of epoxy resin, %	The concentration of the curing accelerator from the mass of epoxy resin, %
1	50	0,5	1,2
2		1,0	
3		1,5	
4		2,0	
5	60	0,5	1,2
6		1,0	
7		1,5	
8		2,0	
9	70	0,5	1,2
10		1,0	
11		1,5	
12		2,0	

Results. Polymeric materials based on organic macromolecular compounds are often used as adhesives, coatings and binding components for polymer composite materials. Based on the above data obtained from a short literature review, the task was to determine the adhesive strength of the obtained samples of a water-emulsion film former based on an epoxy polymer.

The obtained samples of epoxy emulsion, the composition of which is shown in table 1, left in closed containers for 720 hours. After that, work began on determining the adhesive strength of each sample.

Metal plates were used to test the adhesion strength of water-emulsion system samples based on epoxy polymer. The tests were carried out at room temperature after 20 hours of bonding two metal plates using an epoxy emulsion. The following table shows the adhesion strength of epoxy aqueous emulsion to metal (Table 2).

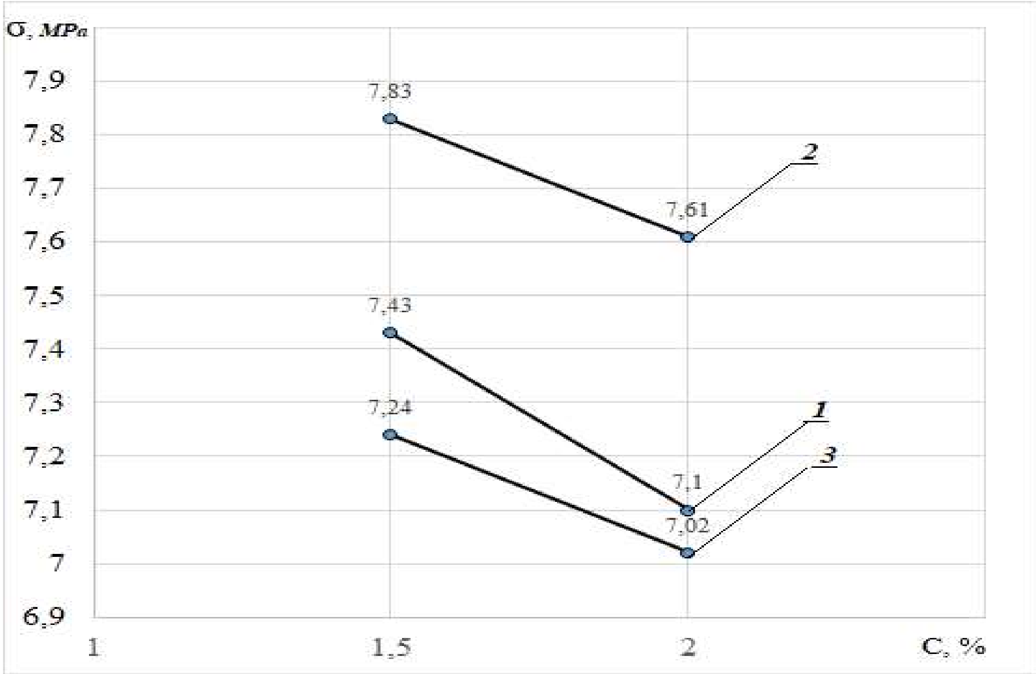
Table 2

Adhesion strength of epoxy water-emulsion systems

Sample numbers [table 1]	Mass fraction of epoxy resin in the emulsion system, %	Emulsifier concentration by weight of epoxy resin, %	Adhesion strength, $\sigma_{adhesion}$, MPa
1		0,5	destruction of the emulsion system
2	50	1,0	destruction of the emulsion system
3		1,5	7,43
4		2,0	7,10
5		0,5	destruction of the emulsion system
6	60	1,0	destruction of the emulsion system
7		1,5	7,83
8		2,0	7,61
9		0,5	destruction of the emulsion system
10	70	1,0	destruction of the emulsion system
11		1,5	7,24
12		2,0	7,02

Discussions. The data obtained from the results of testing the adhesion strength of samples of aqueous emulsions containing epoxy oligomer with concentrations of 50, 60, 70 percent of the total mass of the emulsion system are presented in table 2. The table made makes it possible to compare the performance of twelve samples. From the table it can be seen that all samples of the emulsion system with concentrations of carboxymethyl cellulose 0.5 and 1.0 percent were subject to destruction in the interval of 720 hours. Samples of the emulsion system with concentrations of carboxymethyl cellulose 1.5 and 2.0 percent did not lose the emulsion appearance. Thus, adhesion tests were carried out on samples of emulsion systems with concentrations of carboxymethylcellulose 1.5 and 2.0 percent by weight of the epoxy resin. According to the indicators of the samples that retained the emulsion appearance, a diagram of the dependence of the adhesive strength of the samples of water-emulsion systems of epoxy resin on the concentration of the emulsifier -

carboxymethyl cellulose was compiled. This diagram is shown in Figure 1.



1 - a sample of the emulsion system containing 50% epoxy resin; 2 - a sample of the emulsion system containing 60% epoxy resin; 3 - a sample of the emulsion system containing 60% epoxy resin.

Figure 1. Diagram of dependence of adhesive strength - σ of epoxy aqueous emulsion on emulsifier concentration

The chart in Figure 1 shows that as the emulsifier concentration increases from 1.5 percent to 2.0 percent, there is a trend towards a decrease in adhesive strength for all three samples of water-based epoxy resin systems. An increase in the adhesive strength of the samples is observed with an increase in the concentration of epoxy resin in the emulsion system from 50% to 60%. However, sample number 3 with a 70% epoxy concentration shows a low adhesive strength compared to samples number 1 and 2. The reason for this may be due to an increase in the concentration of the emulsifier. an increase in the concentration of the emulsifier in the emulsion system prevents the timely release of water from the emulsion system and in the system there is a partial non-solidification of the dry residue.

Conclusion. Thus, the experiments carried out in this article indicate the possibility of obtaining a water-emulsion system based on epoxy resin. The possibility of using carboxymethyl cellulose as an emulsifier of an epoxy aqueous emulsion is shown. According to the results obtained, it was revealed that the optimal concentration of carboxymethylcellulose will be 1.5 percent by weight of the epoxy resin. It was determined that the highest adhesive strength among the samples of an aqueous emulsion of epoxy resin was shown by sample number 7, which includes 60 percent of epoxy resin and 1.5 percent of carboxymethyl cellulose by weight of epoxy resin.

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SYNTHESIS OF A NON-ISOCYANATE URETHANE OLIGOMER BASED ON PHTHALIC ANHYDRIDE

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Abstract:

Objective. The purpose of this work is to study the method of synthesizing an oligomer containing urethane groups without the isocyanate method, as well as to conduct an infrared spectroscopic analysis to determine the formed chemical bonds and functional groups in the resulting urethane oligomer. The

influence of the temperature of the reaction mass and the reaction time on the average molecular weight of the resulting urethane oligomer is shown. The optimal temperature-time parameters for carrying out the synthesis process without an isocyanate urethane oligomer have been established.

Methods. To achieve the goal of this study, a method was used to determine the formed chemical bonds and functional groups. Ethylene glycol, urea, formaldehyde, and phthalic anhydride were used to synthesize the urethane oligomer. The urethane oligomer was obtained by the chemical reaction of polycondensation under vacuum. To determine the optimal temperature and time of the polycondensation reaction, samples were selected that differ in the duration of the reaction, as well as in the temperature of the reaction system. The molecular weights of the samples were determined by cryoscopy. A graph of the dependence of the molecular masses of the samples on the duration of the polycondensation reaction at different temperatures was plotted.

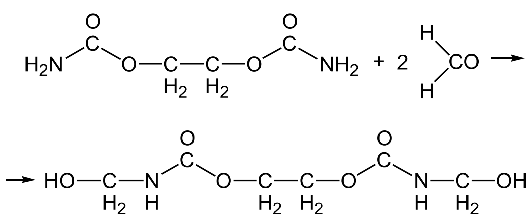
Results. The results of the experiments showed that an absorption band in the region of 1640.55 cm-1 was found in the IR spectrum, explaining the presence of the -CO-NH2 group and an absorption band in the region of 1732.08 cm-1, proving the presence of an unsubstituted urethane group.The study of the molecular weight of the obtained urethane oligomer by the cryoscopic method showed that the molecular weight of the oligourethane reaches 3921. The optimal temperature-time condition for the synthesis of this oligourethane is a chemical reaction at 160 ° C and for 120 minutes.

Conclusion. The results obtained from the study of the urethane oligomer synthesis method without the isocyanate method indicate that the optimal condition for obtaining a urethane oligomer based on phthalic anhydride is the polycondensation reaction for 120 minutes at a temperature of 160 °C. this method allows to obtain without isocyanate urethane oligomer based on ethylene glycol, urea, formaldehyde and phthalic anhydride, with an average molecular weight reaching 3921.

Keywords. Synthesis, isocyanate-free method, urethane oligomer, cryoscopy, IR spectroscopy.

Introduction. This paragraph includes information on the latest scientific advances in the chemistry and technology of non-isocyanate type urethane polymers. Polyurethanes are one of the most used polymers in many modern technologies [1, 2]. However, the use of toxic components, such as isocyanates, in the production process can make the production of polyurethanes extremely toxic and dangerous [3, 4]. For a long time, non-isocyanate sources have been sought for the production of polyurethanes. A significant problem in the technologies for producing non-isocyanate-type polyurethane by the method using cyclic carbonates is the lack of commercially available multifunctional cyclic carbonates [5, 6]. Recent works in the field of new methods for the preparation of cyclic carbonates are primarily devoted to the development of new catalytic systems and the synthesis of monofunctional compounds [7]. Similar catalytic systems are also used for the copolymerization of epoxides with CO2 and ring-opening polymerization of cyclic carbonates, with one or another direction of the reaction depending on the process conditions [8, 9].

Methods. Obtaining a urethane oligomer based on phthalic anhydride begins with a chemical reaction of the interaction of urea with ethylene glycol in a molar ratio of two to one. Next, a chemical reaction of the interaction of the resulting diurethane with formaldehyde in a molar ratio of one to two, respectively, is carried out. As a result, diurethane with terminal hydroxyl groups is formed. The chemical reaction equation for this process is shown below.



To obtain a urethane oligomer based on phthalic anhydride, a polycondensation reaction is carried out between the previously synthesized diurethane diol and phthalic anhydride. Figure 1 shows the chemical reaction equation for the polycondensation of diurethane diol and phthalic anhydride.

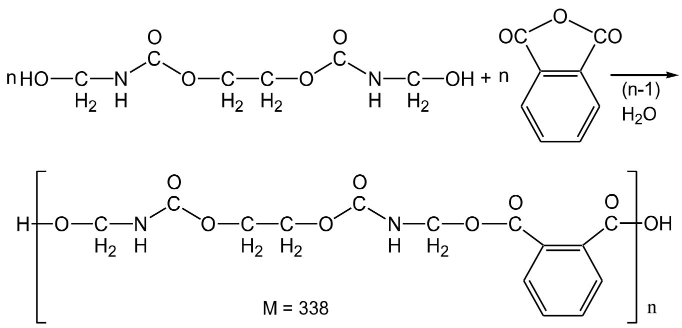


Figure 1. Polycondensation reaction equation between diurethane diol and phthalic anhydride

The mass of one link of the polycondensation oligomer based on phthalic anhydride is 338.

The process of synthesis of urethane oligomer based on phthalic anhydride. The procedure for obtaining diurethane based on ethylene glycol is the first step in the synthesis of urethane oligomer based on ethylene glycol. Based on this product, diurethane diol based on ethylene glycol is obtained. To do this, 100 grams of ethylene glycol diurethane is placed in a flask equipped with a stirrer, dropping funnel, reflux condenser and thermometer. Connect the heating, set to 65 ° C. after the temperature of the reaction mass reaches 65 °C, the stirrer is connected at a rotation speed of 280-300 rpm. Then, through a dropping funnel, 152 grams of a formaldehyde solution with a 20% concentration and 10 grams of ammonia water with a 20% concentration begin to be poured. This stage of the chemical reaction lasts for 150 minutes. After completion of the reaction, water is distilled off from the reaction mass using a vacuum at 60°C for 40 minutes. The resulting diurethane diol is a viscous liquid with a light yellowish tint.

To carry out the process of polycondensation of diurethane diol and phthalic anhydride, 71.5 grams of phthalic anhydride are added to the flask. Then, during 30 minutes with intensive stirring, the temperature of the reaction mass is raised from 60 °C to 130 °C. After, a vacuum is connected to the flask and 10 grams of sulfuric acid solution with a 40% concentration is poured. Next, raise the temperature of the reaction mass to 160 °C. The reaction at the reached temperature proceeds for 120 minutes.To obtain an oligourethane with a terminal urethane group, the temperature of the reaction mass is reduced from 160 °C to 135 °C and 6 grams of urea are added. This reaction step lasts 30 minutes at a given temperature. After completion of the reaction, the vacuum is removed and the resulting product is held at 70°C with slow stirring for 50-60 minutes. The product obtained is a whitish-yellow solid mass, soluble in water.

Determination of the molecular weight of the oligomer by the cryoscopic method. A relatively simple method for determining the molecular weight of a substance is to measure the drop in freezing point of dilute solutions of that substance in a solvent. As one of the colligative properties of dilute solutions, the freezing point decrease depends only on the amount of dissolved particles, but not on their type.

To determine the temperature difference, first determine the freezing point

of the pure solvent, and then the solution of the urethane oligomer in this solvent in a cold mixture using, for example, a Beckmann thermometer. To do this, usually determine the temperature profile near the freezing point and depict it graphically. From the above formula, the molar mass (M) is calculated using formula 1 [10, 11].

$$M = \frac{K \cdot m1 \cdot 1000}{\Delta T \cdot m2} \qquad (1)$$

where: K - cryoscopic constant. For water it is 1.86, for benzene 5.07; ΔT is the temperature difference between the solvent and the solution; m1 is the mass of the dissolved substance; m2 is the mass of the solvent.

Results. Infrared spectroscopy of a urethane oligomer based on phthalic anhydride. To determine the chemical bonds formed during the chemical synthesis of a urethane oligomer based on phthalic anhydride, the samples were studied by infrared spectroscopy (Figure 2).

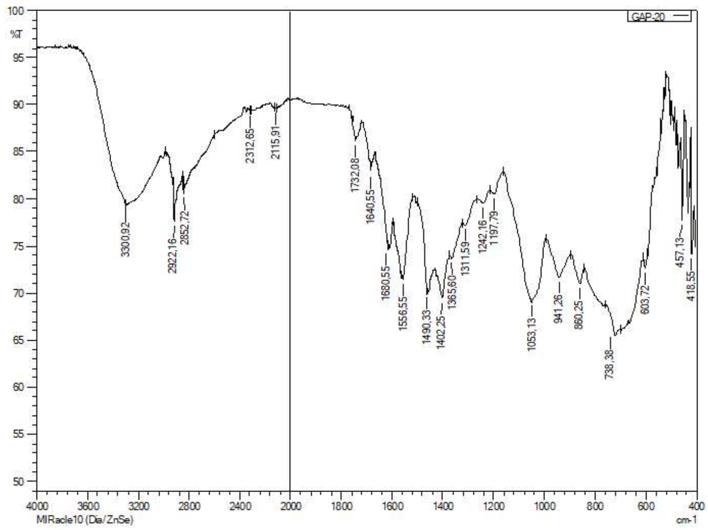


Figure 2. IR spectrum of oligourethane based on phthalic anhydride

The presence of an absorption band in the region of 1640.55 cm^{-1} in the IR spectrum explains the presence of the -CO-NH2 group. The absorption band at 1732.08 cm^{-1} indicates the presence of an unsubstituted urethane group. The absorption band in the region of 1680.55 cm^{-1} corresponds to non-planar bending vibrations of the O-H bond of the carboxyl group associated with the aromatic ring. The absorption band in the region of 1242.16 cm^{-1} corresponds to the stretching vibrations of –O-CO-O-groups. The IR spectrum contains absorption bands of stretching vibrations of -C-H bonds in the region 2922.16 - 2852.72 cm^{-1}. C-O-NH-groups in the IR spectrum are observed in the region of 3300.92 cm^{-1}. When a hydrogen bond is formed, the vibration frequency decreases and the bands broaden. Hydrogen bond absorption occurs in this region in the case of oligomers or polymers. In the IR spectrum, no absorption bands were found in the region caused by stretching vibrations of the hydroxyl group.

The results of infrared spectroscopy confirm the possible chemical structure of the phthalic anhydride-based urethane oligomer shown in Figure 1.

To determine the optimal temperature and time of the polycondensation reaction, samples were selected that differ in the duration of the reaction, as well as in the temperature of the reaction mass. Three polycondensation reactions were carried out at temperatures of 145, 160 and 175 °C.

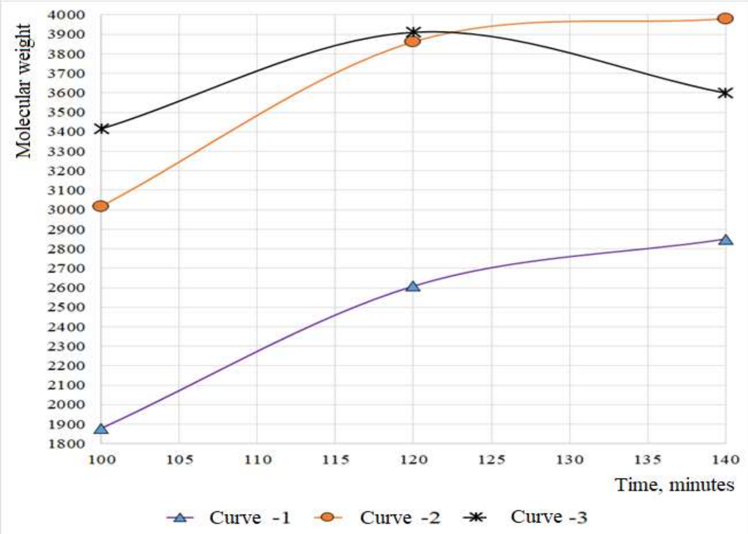
The duration of the three reactions was up to 140 minutes. Oligourethane samples were obtained at 100, 120 and 140 minutes from each reaction system. As a result, 9 samples of urethane oligomer based on phthalic anhydride with different temperature and time conditions were obtained. Then, the molecular weights of the samples were determined by the method of cryoscopy and a graph of the dependence of the molecular weights of the samples on the duration of the polycondensation reaction was plotted. Table 1 sets out the temperature-time parameters of the polycondensation reaction for samples of urethane oligomer based on phthalic acid.

Table 1

Temperature-time parameters of polycondensation of samples of oligourethane based on phthalic acid

Samples No.	Reaction conditions		Molecular weight determined by the method of cryoscopy
	Time minutes	Temperature °C	
1	100		1878,3
2	120	145	2607,6
3	140		2848,9
4	100		3018,4
5	120	160	3862,4
6	140		3981,0
7	100		3417,2
8	120	175	3910,7
9	140		3600,1

Discussions. According to the data obtained from Table 1, a diagram of the dependence of the molecular weight of samples of the resulting urethane oligomer on the time of the chemical reaction of polycondensation and the temperature of the reaction mass was compiled (Figure 3). This dependence diagram helps to compare the indicators of the table and determines the direction of the polycondensation reaction.



Curve-1 – samples obtained at 145°C; Curve-2 - samples obtained at 160 °C; Curve-3 - samples obtained at 175 °C

Figure 3. Effect of temperature and time of polycondensation on the molecular weight of urethane oligomer samples based on phthalic anhydride

The diagram of the dependence of the molecular weight on the time of the temperature flow shows that when the polycondensation reaction is carried out at 145 ° C, the molecular weight of the urethane oligomer based on phthalic anhydride increases from 1878 to 2607 at a noticeable rate up to the 120th minute of the reaction, but then a slowdown in the growth of the molecular weight is observed (Figure 3 , curve-1). The molecular weight of the oligourethane obtained at 160°C increases by 844 units at the 120th minute and reaches 3862, but the continuation of polycondensation up to 140 minutes shows an increase in molecular weight by only 119 units (Figure 3, curve-2). The direction of curve-3 shows the course of the polycondensation reaction at 175°C. Observing the direction of curve-3, we can conclude that the reaction system begins the reaction of transesterification or thermal destruction of the urethane oligomer based on phthalic anhydride.

Based on the data obtained, it should be concluded that the optimal condition for obtaining a urethane oligomer based on phthalic anhydride is to carry out the polycondensation reaction for 120 minutes at a temperature of 160 °C.

Table 2 shows the process parameters for obtaining an oligomer containing urethane groups based on phthalic anhydride.

Table 2

Parameters for the synthesis of a urethane oligomer based on phthalic anhydride

Stages	Synthesis parameters				
	Time, minutes	Temperature, °C	Pressure, atm.	pH environment	Mechanical impact
1. Synthesis of diurethane based on ethylene glycol	150	130	atmospheric	8,5-9,5	Mixing, 150-200 rpm
2. Condensation reaction of formaldehyde with the resulting diurethane	150	65	atmospheric	8,5-9,0	Mixing, 280-300 rpm

3. Residual water distillation	40	60	-0,8 atm.	7,5-8,0	Mixing, 140-150 rpm
4. Polycondensation	120	160	-0,4 – -0,5 atm.	6,0-6,5	Mixing, 100-130 rpm

Conclusion. Thus, the experiments carried out in this article indicate the possibility of obtaining an oligomer containing urethane groups based on ethylene glycol, urea, formaldehyde, and phthalic anhydride. The results obtained by studying the method of synthesis of a urethane oligomer without the isocyanate method indicate that the optimal condition for obtaining a urethane oligomer based on phthalic anhydride with a molecular weight of 3862 is to carry out the polycondensation reaction for 120 minutes at a temperature of 160 °C. The results of infrared spectroscopy confirm the possible chemical structure of the phthalic anhydride-based urethane oligomer shown in Figure 1.

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WATER VAPOR ADSORPTION ISOTHERM ON ZEOLITE AgZSM-5

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Abstract:

Objective. This paper presents the isotherm of water molecule adsorption on AgZSM-5 zeolite at a temperature of 303 K. The adsorption isotherm was measured using an improved microcalorimeter connected to a universal high vacuum apparatus. Differential values of free energy were calculated from thermodynamic equilibrium values. The relationship between the adsorption amount and energy properties of water molecules in AgZSM-5 zeolite, as well as the sorption mechanism from the initial zone to the saturation zone, and it was found that water molecules fill 56.3% of the volume of zeolite. It was proved that 85% of the total adsorption amount is at a relative pressure of P/Ps=0.3. The adsorption isotherm was recharacterized by the three-state equation of the micropore saturation theory, and it was shown that the theoretically calculated values were in full agreement with the experimentally obtained values.

Research method. The adsorption isotherm was measured with high accuracy and stability using a system consisting of a Tiana-Calve differential automated microcalorimeter (DAK-1-1A) connected to a universal high-vacuum apparatus. The adsorption-calorimetric method used in this research makes it possible to obtain high-precision molar thermodynamic descriptions, as well as to reveal detailed mechanisms of adsorption processes occurring in adsorbents. Adsorption measurements and adsorbate dosing were performed using a high-vacuum adsorption device. The device allows dosing of adsorbate by gas-volume and liquid-volume methods. Baratron B627 diaphragm pressure gauge was used to measure equilibrium pressure down to 0.8 mmHg. The adsorption-calorimetric method allows the research of nanostructured adsorbents, the detailed discovery of the main thermodynamic properties and mechanisms of adsorption processes occurring in adsorbents and catalysts.

Results. It was found that water adsorption on AgZSM-5 zeolite at a temperature of 303 K is the main thermodynamic characteristics from the initial area to the saturation pressure, there is a regular relationship between the adsorption amount and energy characteristics, the adsorption mechanism, the sorption volume and energy values of this zeolite are higher than monovalent cation zeolites. In the process of adsorption, the formation of an ion/molecular complex at the intersection of straight and sinusoidal channels between water molecules and Ag cations was proved.

Conclusion. The results of the carried out adsorption-calorimetric research allow to obtain the main thermodynamic functions of the studied systems, which are necessary for the development of theoretical concepts of physical adsorption, as well as for the calculation of processes and devices of sorption technology.

Keywords: adsorption, heat of adsorption, free energy, adsorption isotherm, pressure, relative pressure, entropy, kinetics, calorimeter, water.

Introduction. Cations, considered the main active center of zeolites, play an important role in the adsorption of polar, non-polar and quadrupole molecules. By determining the main thermodynamic characteristics of the adsorption of test molecules such as water, methanol and ammonia, the number of energetically active centers (cations) in the same type of crystallographic positions is determined [1-5].

A stepwise decrease in the heat of adsorption of polar molecules in zeolites of the ZSM-5 type with alkali metal cations indicates the stoichiometric interaction of these molecules with cations that compensate for the negative charge of the lattice. For example, water and alcohols Cu(H2O)10+2, Cs(H2O)6+, Li(H2O)4+ Na(H2O)4+, Na(CH3OH)4+, Na(C2H5OH)4+, K(H2O)4+, H(H2O)4+, NH4(H2O)4+ ion-molecular complexes have a step-like change [6-12].

The effect of different cationic forms of ZSM-5 zeolites on water adsorption is studied by direct experimental measurement of isobars and adsorption isotherms. It has been shown that water molecules are more strongly bound in monovalent alkaline cation forms

compared to adsorption in zeolite in N+ cationic form. In addition, the difference in the amount of water adsorption in NaZSM-5 and NZSM-5 zeolites was evident [13]. Using the method of molecular dynamics, the authors [14-17] studied the adsorption of water molecules in the pores of hydrophobic ZSM-5 zeolite, that is, silicalite-1. As a result of the study, the adsorption properties of water in hydrophobic nanopores at the molecular level were determined and the spontaneous condensation of water was described.

In the adsorption of ammonia, the authors showed the formation of Na(NH3)8 complex. 24 hydrogen molecules form a wrap around the Na cation in the center of the intersection of straight and zigzag channels of zeolite [6, 18, 19].

In this work, the properties of adsorption interaction of water molecules with AgZSM-5 nanostructured synthetic zeolite are considered. To characterize the adsorption properties of zeolites, the dependence of the adsorption amount of water molecules on the equilibrium pressure, that is, the isotherm and kinetics, were determined. The amount of Ag+ cations in this ZSM-5 (Si/Al=27.5) zeolite is 0.304 mmol/g.

Research methods and materials. The strength of the adsorbate-adsorbent interaction and, consequently, the "acidity strength" can be analyzed by conducting temperature-programmed desorption of adsorption. A more direct and accurate way to determine the acidity, the distribution of its centers, and the thermal equilibrium time is the adsorption-calorimetric measurement method obtained during the adsorption process.

The adsorption-calorimetric method used in this work allows obtaining high-precision molar thermodynamic descriptions and revealing the detailed mechanisms of adsorption processes taking place in adsorbents and catalysts. Adsorption measurements and quantification of adsorbate were performed using a universal high vacuum adsorption device. The device allows to provide the measured amount of adsorbate both by gas-volumetric and volumetric-liquid methods. A modified Tiana-Calve microcalorimeter DAK-1-1A was used as a calorimeter with high accuracy and stability.

The adsorption device is a glass-vacuum device consisting of capillary microburettes and mercury valves. The device consists of an adsorbent ampoule inside a microcalorimeter, a B627 baratron for measuring low pressures (from 10-5 mmHg to 1 mmHg), 1 mmHg. It consists of a measuring part with a mercury U manometer for measuring pressures and above, a capillary for gas storage and preparation, adsorbates in the liquid phase, and a vacuum pump system for creating a high vacuum.

The adsorption study was carried out on Cu2+ZSM-5 zeolite at a temperature of 303 K. The unit cell composition of zeolite is Ag1.72 [(SiO2)96.63(AlO2)1.72].

Results. The corresponding isotherm of water adsorption on AgZSM-5 zeolite in logarithmic coordinates is presented in Figure 1 and it confirms the energetic data [20]. At small saturations, the equilibrium pressure is 0.0046 mmHg. ($P/P_s=1{,}45\cdot10^{-4}$) reaches. This indicates strong adsorption of water to forms of hydrogen, ammonium, cesium and silicalite [21-23]. The adsorption isotherm was brought up to 5.35 mmol/g (or 17.6 molecules/cation) at a relative pressure of P/Ps=0.67 (or R=21.16 mmHg). If the density of water in AgZSM-5 zeolite is taken as a normal liquid at the experimental temperature and compared with the volume occupied by a water molecule at saturation, then water occupies ~0.0963 cm3/g of the sorption volume of AgZSM-5 zeolite and makes up ~56.3%. This value is ~53% in Cu2+ZSM-5 form of ZSM-5 zeolite, ~51% in CsZSM-5 zeolite, and ~54% in LiZSM-5 zeolite.

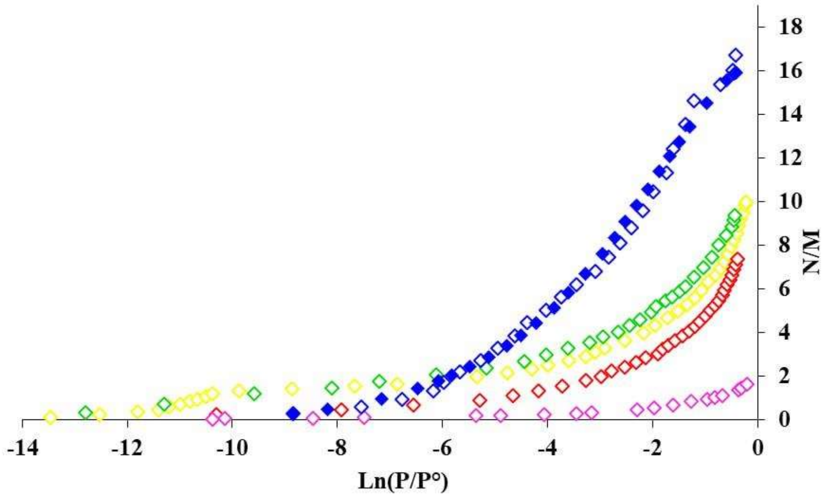

Figure 1. Adsorption isotherm of water molecules in ZSM-5 zeolites with ◊-Ag^+, ◊-Cs^+, ◊-Li^+, ◊-Na^+ cations and ◊-silicalite at a temperature of 303 K. ♦-values of the general equation of micropore volume saturation theory

The adsorption isotherm shows that silver cations are in a strong ion-molecular complex bond with water molecules in the initial region. The isotherm initially moves linearly towards the abscissa axis at the adsorption amount of 0.3 mmol/g up to P/Ps=0.00115 (R=0.0367 mmHg). The formation of a step in the amount of this adsorption means the formation of a monomeric 1N2O:Ag ion-molecular complex, as in differential heating. After the 1N2O:Ag complex, P/Ps=0.009 (R=3 mmHg) increases linearly and steeply upwards with an adsorption amount of 2.74 mmol/g. process is completed. Next, water molecules are adsorbed in the right sinusoidal channels of the zeolite, that is, in the cation-free parts. After 15N2O:AgZSM-5 adsorption, the equilibrium pressure begins to increase sharply. Therefore, six water molecules are sufficiently strongly bound even in the non-cationic part of the zeolite. The next three water molecules form an isotherm step on adsorption. In general, the adsorption isotherm is above lithium, cesium, sodium, ammonium, and protonated forms of ZSM-5 zeolite.

The water adsorption isotherm on AgZSM-5 zeolite is also completely described using the equation of the three-member micropore volume saturation theory [25]:

$$a=0,837\exp[-(A/16,84)^3] + 4,153\exp[-(A/7.53)^2] + 0,650\exp[-(A/0,39)^1] \quad (1)$$

where, α - adsorption value (mmol/g), A=RTlnPs/P, the work done in transferring the gas from the surface (pressure P°) to the equilibrium gas phase (pressure R) (kJ/mol). It can be seen from Figure 1 that the values calculated in the theory of volume saturation of micropores agree with the values obtained in the experiment. Indices 1, 2 and 3 in the quantities of Equation 1 are descriptions of the interaction of adsorbates on cations. Quantities with an index of 1 describe the adsorption of a water molecule on cations with a strong interaction, an index of 2 - on relatively weak interactions on cations, and an index of 3 - weak interactions on cations. In the adsorption of water - AgZSM-5 system, based on the theory of volumetric saturation of micropores, the values of the terms of the equation (1) are equal to the following: for the first term a01=0.837 mol/g, E01=16.84 kJ/mol, n1=3; for the second term - a02=4.153 mmol/g, E02=7.53 kJ/mol and n2=2; for the third term - a03=0.65 mmol/g, E03=0.39 kJ/mol and n3=1.

Figure 2 shows an isotherm graph of relative pressure (P/Ps) as a function of the amount of adsorption. The isotherm corresponds to the Branauer 1 classification, that is, water is adsorbed in zeolite only in micropores. This zeolite does not have meso and macro pores.

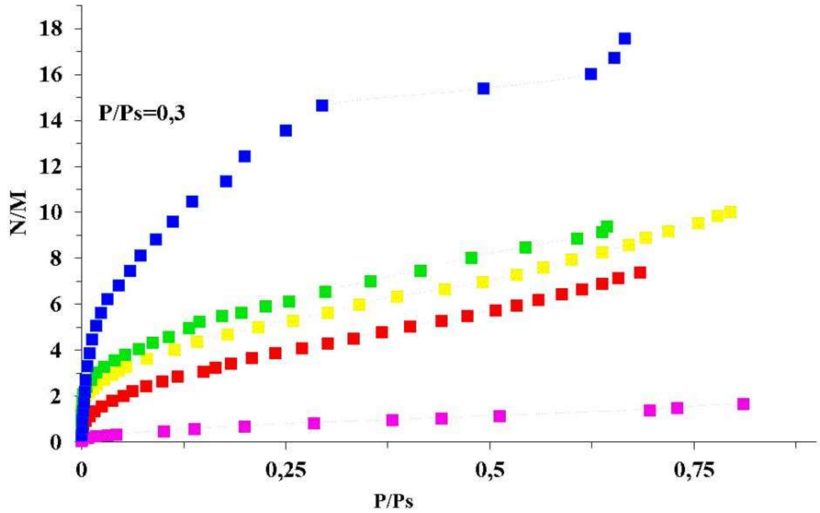

Figure 2. Isotherm of dependence of relative pressure (P/Ps) on the amount of water molecules adsorption in ZSM-5 zeolites with ■-Ag^+, ■-Cs^+, ■-Li^+, ■-Na^+ cations and ■-silicalite at a temperature of 303 K

From the isotherm, 15 water molecules are adsorbed at a relative pressure of P/Ps= 0.3, and a sharp increase in relative pressure is observed during the sorption of the next 3 water molecules. Therefore, the main mass of water (85%) is absorbed at low pressures. At this relative pressure, there is one water molecule in silicalite (53%), 4 water molecules in the cesium form of zeolite (60%), 6 water molecules in the lithium form (56%), 7 water molecules in the sodium form (70%), and 7 water molecules in the ammonium form (58 %) 10 water molecules are adsorbed [21-22, 25].

Conclusion. Water molecules are adsorbed at high energy values in AgZSM-5 nanostructured synthetic zeolite. The total amount of adsorption is 17.6 water molecules, and an ion-molecular complex with a ratio of 9N2O:Ag+ is formed in the first coordination sphere. Also, 8.6 more water molecules are adsorbed in the second coordination sphere, i.e. in the cation-free silicalite part of the zeolite. 85% of the total amount of adsorption corresponds to the relative pressure P/Ps=0.3. 56.3% of the volume of zeolite is filled with water molecules. This is 30% more than the volume occupied by water in the non-cationic form of zeolite. The isotherm of the water molecule in the silver cation form of ZSM-5 zeolite is above that of the monovalent alkali metal cation form. In the process of adsorption of water molecules, up to 0.3 mmol/g of adsorption, copper cations migrate from the hidden state to the intersection of the straight and zigzag channels of zeolite.

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STUDY OF THE CATALYTIC SYNTHESIS OF O-VINYL ETHER BASED ON MONOETHANOLAMINE AND ACETYLENE

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Abstract:

Objective. Synthesis of vinyl esters by vinylation of monoethanolamine with acetylene in superbasic medium was investigated. The effect of temperature, catalyst, reaction time, and other factors on the yield of vinyl ether of monoethanolamine has been studied. Also, quantum-chemical calculations theoretically calculated the active reaction centers of monoethanolamine, the distribution of atomic charges.

Methods. Based on literature analysis, monoethanolamine was exposed to acetylene with KOH catalyst, DMSO solvent medium, acetylene pressure 4 atm, temperature 80-95°C for 5-7 hours. The spatial structure of the monoethanolamine molecule and the distribution of atomic charges were studied using the Chem 3D Ultra 10.0 program.

Results. The yield of vinyl ester of monoethanolamine is significantly affected by the reaction temperature and time. The yield of O-vinyl ether increased with increasing temperature from 80°C to 90°C and increasing the reaction time from 3 to 6 hours. When the temperature rises to 95°C and the vinylization process is extended to 7 hours, the product yield decreases. This situation is explained by a decrease in the solubility of gaseous acetylene in the solvent and by the processes of oligomerization of various vinyl esters.

Conclusions. It was found that monoethanolamine and acetylene give o-vinyl ether with a maximum content of 54.6% for 6 hours at a temperature of 90 ° C and a pressure of 4 atm.

Keywords: monoethanolamine, vinylation process, vinyl ether, hydroxyl group, nucleophilicity, charge distribution, reaction time, yield of monoethanolamine vinyl ether.

Introduction. Today, topical issues are the synthesis of new types of organic substances, obtaining compounds with different properties on their basis by introducing modern technologies in the chemical industry. In this regard, important issues are the creation of various biologically active chemicals, pharmaceuticals with unique properties, polymeric substances, adhesives and paints, which are widely used in the cultivation of agricultural products. These compounds include simple and complex vinyl ethers containing hydroxyl, carboxyl and amino groups in the molecule, vinylized with acetylene [1-8].

Methods. Vinyl compounds synthesized in the world in recent years are widely used in agriculture and pharmaceuticals due to their high physiological activity. Vinyl ethers have been synthesized in various ways. In particular, the synthesis of vinyl ethers and esters by vinylation of compounds containing hydroxyl and carboxyl groups – alcohols, carboxylic acids, and hydroxy acids—with acetylene has been well studied. In particular, the synthesis of vinyl ethers in an alkaline medium according to the Favorsky-Shostakovsky method is widely used [9-14].

Obtaining vinyl derivatives by transferring a hydrogen atom of the hydroxyl group to the triple bond of acetylene is one of the most common methods in organic synthesis. The use of

superbasic media in this method serves as an important factor in improving the performance of the product [9-16].

Although the vinylation of alcohols, acids, and hydroxy acids with acetylene has been relatively well studied, the processes of vinylation of amino alcohols have been less studied.

The presence of amino groups and hydroxyl groups in the monoethanolamine molecule complicates the processes of vinylation. Because in vinylation processes, the vinyl group can be replaced by an amino group hydrogen or a hydroxyl group hydrogen. Therefore, the molecular structure and charge distribution were theoretically calculated using Chem 3D Ultra 10.0 software to predict the course of vinylation reactions.

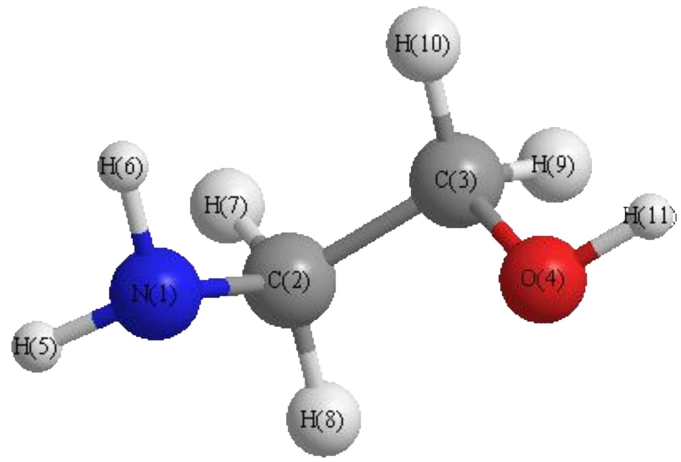

Figure 1. Spatial structure and charge distribution of the monoethanolamine molecule

Here, -0.284 [N(1)]; 0.031 [C(2)]; 0.151 [C(3)]; **-0.374 [O(4)]**; 0.110 [H(5)]; 0.110 [H(6)]; 0.009 [H(7)]; 0.024 [H(8)]; 0.012 [H(9)]; 0.012 [H(10)]; 0.199 [H(11)].

It can be seen that the oxygen atom in the hydroxyl group of monoethanolamine O (4) (-0.374 eV) exhibits more nucleophilic properties of the molecule. At the same time, the electrophilicity of the proton of the hydroxyl group in the H (11) molecule (0.199 eV) is high compared to other protons. This ensures the orientation of the acetylene molecule in the interaction with monoethanolamine towards the hydroxyl group and the replacement of the vinyl group by the hydrogen of the hydroxyl group.

Based on these theoretical quantum-chemical calculations, it was concluded that the main product of the vinylation processes in the work are O-vinyl ethers.

The process of vinylation of monoethanolamine using acetylene is carried out according to the following scheme.

$$NH_2{-}CH_2{-}CH_2{-}OH + CH{\equiv}CH \xrightarrow[{}^{o}t]{KOH/DMSO} NH_2{-}CH_2{-}CH_2{-}O{-}CH{=}CH_2$$

Results. In this work, we studied the influence of various factors on the vinylation of monoethanolamine in a KOH/DMSO medium in the presence of acetylene, the optimal synthesis conditions were determined. In the course of research, experiments were carried out at an acetylene pressure of 4 atm. The effect

of temperature and time on the vinylation reaction in the presence of 20% KOH catalyst relative to the mass of monoethanolamine was studied. The results obtained are presented in tabl. 1.

Table 1

Temperature and reaction to the reaction of monoethanolamine with acetylene duration effect (the amount of KOH catalyst in relation to the mass of monoethanolamine is 20%)

Temperature, °C	Reaction time, hour	Output of vinyl ester, %
80	5	38,3
80	6	48,6
80	7	50,1
85	5	49,7
85	6	51,0
85	7	51,3
90	5	53,5
90	6	54,6
90	7	53,1
95	5	50,2
95	6	51,3
95	7	50,5

Discussions. As can be seen from the results, temperature markedly affects the yield of monoethanolamine vinyl ether. When the temperature rises from 80°C to 95°C, the product yield increases from 38,3 to 54,6%. As a result of a further increase in temperature, the yield of the product decreased. This condition is explained by a decrease in the solubility of acetylene in a solvent at very high temperatures, as a result of which its concentration also decreases, the reaction rate and the yield of the resulting product decrease.

In addition, increasing the reaction time from 5 to 6 hours increases the product yield. However, by 7 o'clock the yield of the product is reduced. With a long course of the reaction at high temperatures, the formation of resinous oligomeric substances with vinyl esters and other reaction intermediates is observed with dimethyl sulfoxide [14-20].

The synthesized vinyl esters were purified and isolated by vacuum desorption and column chromatography. The purity of the product was determined by the GSX method, the elemental composition was calculated, and the structural formula was analyzed by IR spectra.

Conclusion. Monoethanolamine was found to form monoethanolamine o-vinyl ester with a maximum content of 54.6% when exposed to acetylene for 6 hours at 90° C. and 4 atm pressure in a high KOH/DMSO environment.

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SOLUBILITY OF COMPONENTS IN THE SYSTEM $NaClO_3$ $CO(NH_2)_2$-$NH(C_2H_4OH)_2$ -H_2O

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Abstract:

Solubility of components in $NaClO_3$ $CO(NH_2)_2$ - $NH(C_2H_4OH)_2$ -H_2O from total freezing temperature (-67.4**°C**) to 40.0**°C** has been studied. A polyhermic solubility diagram has been constructed on which the areas of crystallization of ice, carbamide, sodium monocarbamidochlorate, and diethanolamine have been delimited. The system relates to a simple eutonic type.

Keywords: components, polyhermic, diagram, ice, carbamide, crystallization, sodium, monocarbamidochlorate, diethanolamine, temperature.

Introduction. The search and development of lowtoxic, highly effective and mild defoliants that do not adversely affect the yield of cotton, the technological performance of cotton fiber is an urgent problem in cotton growing.

Cotton growing is one of the most important branches of agriculture in Uzbekistan. In case of chemical impact on cotton in order to remove leaves, highly effective defoliants are needed, providing more than 80% fall of cotton leaves in one treatment at low consumption rates, acting “softly” on plants, and therefore not negatively affecting seed oil content, yield, quality cotton fiber and do not clog it [1, 2]. Meanwhile, the sodium chlorate produced in the republic and used as a cotton defoliant does not fully meet the modern requirements of cotton growing [3, 4]. The "rigidity" of its effect on plants requires the creation of new effective, mild defoliants for plants.

In this regard, special attention is paid to the production of highly effective, low-toxic and physiologically active defoliants. The existing chlorate-based defoliants do not meet modern requirements for defoliants. It is known that the defoliating effect of chlorates is always to some extent accompanied by a desiccation effect [5, 6].

When explaining the growth activity of ethanolamines, it should be taken into account that in the presence of carbon dioxide and oxygen, ethanolamines can form glycerol, glycol, oxalic, formic, naphthic, and acetic acids, which belong to the group of growth substances [7–8]

For successful defoliation of cotton, preparations are needed that provide a high degree of leaf fall and bolls opening. One of the possible ways to solve this important

problem is to obtain and use for defoliation chlorate-containing defoliants together with compounds containing $-CH_2-CH_2-$ ethylene group. These compounds include ethanolamines and their derivatives. They, penetrating into plants, increase the level of ethylene in the plant body. This contributes to the acceleration of deleafing and the full ripening and opening of cotton bolls [9-10].

Objects and methods of research. For the physicochemical substantiation of the process of obtaining an effective defoliant, the solubility and interaction of components in the $NaClO_3{\cdot}CO(NH_2)_2$-$NH(C_2H_4OH)_2$-H_2O system was studied in a wide temperature and concentration range by the visual-polythermal method [11].

Sodium monocarbamidochlorate synthesized by introducing sodium chlorate into pilaf at a molar ratio of 1:1 was taken as the initial components. Diethanolamine used grade "h", further purified by distillation under vacuum.

Results and discussion. The $NaClO_3{\cdot}CO(NH_2)_2$-$NH(C_2H_4OH)_2$ - H_2O system was studied by us using eight internal cuts, from the temperature of complete freezing -67.4**°C** to 20.0℃. Of these, sections I-IV were drawn from the side of $NaClO_3{\cdot}CO(NH_2)_2$-H_2O to the top of $NH(C_2H_4OH)_2$, sections V-VIII were studied from the side of $NH(C_2H_4OH)_2$-H_2O to the top of $NaClO_3{\cdot}CO(NH_2)_2$.

The binary system $NH(C_2H_4OH)_2$ - H_2O was considered by a number of authors [12-23]. The results obtained by us are in good agreement with the literature. The solubility of sodium monocarbamidochlorate in water was studied by us earlier. According to the results obtained, the crystallization branches of ice, carbamide and sodium monocarbamide chlorate were revealed on its diagram. The eutectic point of the system corresponds to 57.0% $NaClO_3{\cdot}CO(NH_2)_2$ and 43.0% H_2O at -28.2℃.

Based on the results of the study of binary systems and internal sections, a polythermal solubility diagram of the ternary system was constructed. On the phase diagram of this system, the fields of crystallization of ice, carbamide, sodium monocarbamide chlorate, and diethanolamine are demarcated (Fig 1.).

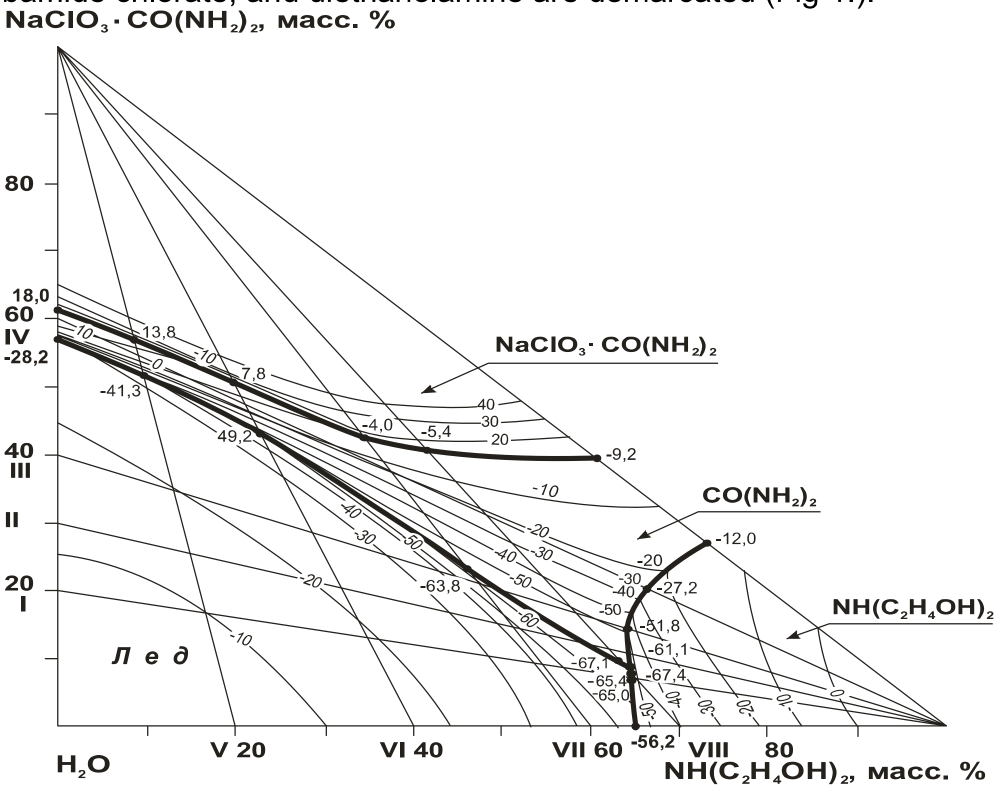

Fig 1. Solubility diagram of system $NaClO_3{\cdot}CO(NH_2)_2$-$NH(C_2H_4OH)_2$-H_2O

These fields converge at the triple nodal point of the system, for which the chemical composition of the equilibrium solution and the corresponding crystallization temperature are determined (Table).

Table 1

Double and triple point systems $NaClO_3 \cdot CO(NH_2)_2$ – $NH(C_2H_4OH)_2$ – H_2O

Liquid phase composition, %			Crystallization temperature, °C	Solid phase
$NaClO_3 \cdot CO(NH_2)_2$	$NH(C_2H_4OH)_2$	H_2O		
61,4	-	38,6	18,0	$NaClO_3 \cdot CO(NH_2)_2 + CO(NH_2)_2$
57,0	8,8	34,2	13,8	-//-
50,9	20,0	29,1	7,8	-//-
42,6	35,0	22,4	-4,0	-//-
41,0	41,8	17,2	-5,4	-//-
39,8	60,2	-	-9,2	-//-
57,0	-	43,0	-28,2	Ice + $CO(NH_2)_2$
51,8	9,9	38,3	-41,3	-//-
43,0	23,0	34,0	-49,2	-//-
23,4	46,0	30,6	-63,8	-//-
9,8	63,0	27,2	-67,1	-//-
8,8	64,5	26,7	-67,4	Ice + $CO(NH_2)_2$+ $NH(C_2H_4OH)_2$
7,8	64,5	27,7	-65,4	Ice + $NH(C_2H_4OH)_2$
7,4	64,5	28,1	-65,0	-//-
-	65,0	35,0	-56,2	-//-
11,0	64,3	24,7	-61,1	$CO(NH_2)_2 + NH(C_2H_4OH)_2$
14,5	64,0	21,5	-51,8	-//-
20,2	66,2	13,6	-27,2	-//-
27,0	73,0	-	-12,0	-//-

The polythermal diagram plots the solubility isotherms of the components every 10°C. To refine the nodal triple points, the projections of the polythermal solubility curves onto the corresponding lateral water sides of the concentration triangle were constructed.

It can be seen from the given data that in the system under study there is no formation of new chemical compounds based on the initial components. The system belongs to the simple eutonic type. In this system, a salting-out effect of diethanolamine on the $NaClO_3 \cdot CO(NH_2)_2$ salt is observed, which increases with increasing temperature and increasing the concentration of components in the system.

Conclusions. The results of the studied system indicate the possibility of obtaining a new effective, ethylene-containing defoliant based on the initial components, where there is a minimal salting-out effect of the components on each other and the components retain their individuality in the form of defoliating and nutritional activity.

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UDK 661.183.2

TECHNOLOGICAL BASIS OF ACTIVATED CARBON PRODUCTION PROCESS THROUGH PROCESSING OF PLUM SEED WASTE

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Abstract:

Objective. The article describes the technological properties of the process of obtaining an import-substituting adsorbent with high adsorption properties from local raw materials - plum kernel waste, obtained through processing. It is assumed that these adsorbents are intended for the treatment of wastewater from industrial enterprises.

Methods. Research methods were carried out on the basis of samples, methods and normative indicators of GOST, presented in the literature.

Results. According to the results, activated carbon with steam at 800 ^{0}C showed its efficiency with high adsorption properties.

Conclusion. In conclusion, it can be said that after thermal pyrolysis and steam treatment, the release of O_2 and Si elements in the grains causes an increase in the number of carbon and high adsorption properties of the obtained activated carbon.

Keywords: adsorption, desorption, adsorbate, isotherm, plum kernel waste, pyrolysis, steam activation, tar, ash content, moisture, benzene.

Introduction. The problems of large tons of waste from the agriculture and food industry of our republic require the search for effective ways to solve them. In

particular, the expediency of using plum seed waste as a raw material for the production of activated carbon is interesting as another new object to search for efficient methods of obtaining expensive activated carbons that replace imports, as well as to eliminate the waste problem. The article describes the pyrolysis of these wastes and the technological basis of the activation of the obtained carbonates with water vapor. This task is very urgent due to the practical absence of local production of these adsorbents in our country and the need for effective use, disposal of these wastes, as well as deep cleaning and neutralization of wastes from public enterprises. The technology of processing these wastes into activated carbon is the most optimal and cheap, pyrolyzing them with the production of products of this operation (carbonizates) and activating such carbonized materials with water vapor [1]..

Methods. At the beginning of the study, 200 g of plum stones were taken and subjected to pyrolysis by dry roasting at a temperature of 300 °C to 800 °C in an inert atmosphere without access to oxygen. Carbonization occurs in the temperature range from 450 °C to 600 °C. [6,7]. The moisture content of the pyrolyzed samples was determined on an MA 210.R instrument. The ash content was determined according to GOST 11022-95. [2,4]. **Weight method.** In this method, the adsorbent is weighed before and after adsorption equilibrium has been established. The increase in mass indicates the amount of adsorption. There are two types of weights - spring and manual. To implement the weighing method, it is advisable to use the device "Mac Ben Bakra". The adsorbent cup is attached to a coil of quartz plate attached to a glass tube. The spiral is pre-calibrated by loading analytical weights into the cup and measuring the length of the resulting spiral. Typically, quartz spirals obey the HUK law well, that is, their elongation is strictly proportional to the increase in mass [5]. Determination of adsorption activity was carried out according to GOST 6217-74. [3,4].

Results and their discussion. The results showed that the original plum kernel content was C 61.1%, O_2 38%, Si 0.9%, and after thermal pyrolysis at 500 °C for 2 hours, C was 94.4%, O_2 5.6%, After steam activation at 800 °C, C is 99.5%, Ca is 0.5%, and their elemental composition was investigated using SEM analysis (EVOMA 10 brand scanning electron microscope). Moreover, when these samples were examined by absorption of benzene vapor in the McBen Bakra device, the sample pyrolyzed at exactly 800 °C showed high adsorption activity. This result again confirmed the results of SEM analysis.

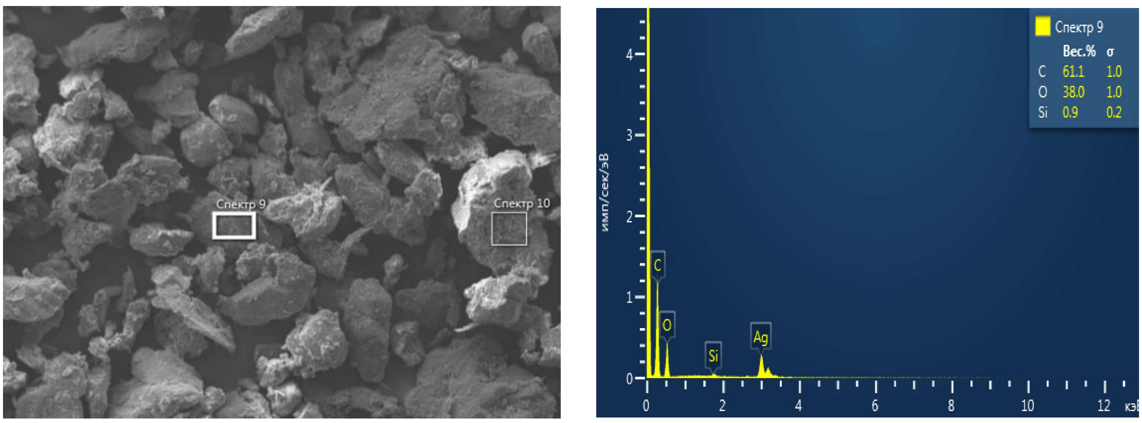

Figure - 1. SEM analysis indicators of plum kernel

As you can see from this picture, the composition of plum kernel is 61.1% S, 38% O_2 and 0.9% Si. In order to increase the C content and adsorption properties of the kernel by reprocessing, the work began with the thermal pyrolysis of plum kernel waste prepared in advance.

Experimental part. At the beginning of these experimental studies, gaseous argon was supplied at a pressure of 0.2 atmospheres to displace air from the pyrolysis unit. Initially, the current was brought to 27 volts for pyrolysis at 300 °C, and the environment was operated at 62 volts when increased to 700 °C. Gaseous argon was supplied at a pressure of 0.2 atmospheres for every 100 °C increase in temperature. In the pyrolysis unit, the temperature increased by 5 °C per minute with an increase in temperature in the range of 200–300 °C and by 7 °C per minute with an increase in temperature in the range from 400 °C to 800 °C. [8]. In the process of activation by this method of pyrolysis, a decrease in the mass of activated carbons obtained from local waste (plum stones) obtained as raw materials is characterized by the release of resins, various functional groups and water vapor from their composition. Observations showed that when the temperature rose to 200 °C, white smoke began to come out of the outlet hose of the pyrolysis plant. This smoke was especially abundant in the temperature range from 350 °C to 550 °C [8,9]. From this we can conclude that resins, hydrocarbons and water vapor in the grain are released in the greatest amount at this temperature. As part of this research work, the effect of temperature on the weight loss of the samples was studied. At the same time, the humidity and ash content of the obtained carbon adsorbents were also studied. The results obtained are presented in the table below.

Table 1.

Influence of the carbonization process on mass loss and properties

№	Pyrolysis temperature, ^{0}C	Weight before heat processing, gr	Weight after heat processing, gr	Output performance after heat processing, %	Moisture %	Ash content %
1	300	200	61,22	30,61	3,772	1,21
2	400	200	59,26	29,63	3,561	1,32
3	500	200	57,20	28,60	3,475	1,34
4	600	200	55,14	27,57	2,902	1,45
5	700	200	52,15	26,07	2,896	1,58
6	800	200	50,41	25,20	2,702	1,91

The next research work was the activation of the resulting pyrolysis samples with steam. The purpose of activating pyrolysis samples is to increase the amount of carbon in the sample, to determine micro- and mono-capacitive sizes. For this, a sample pyrolyzed at 500 °C determined by the rapid method was selected [11]. This sample, when examined by SEM analysis, showed a retention of 94.4% C and 5.6% O_2.

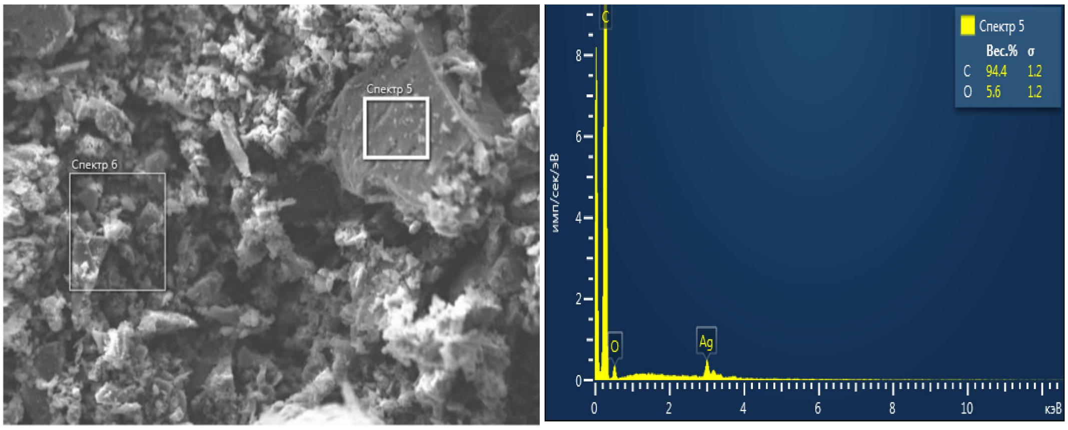

Figure 2. SEM analysis of the sample pyrolyzed at 500 °C

The sample taken for analysis was placed in a special device for steaming and started heating by adjusting the temperature to 800 ± 20 °C and the current to 27 volts. This voltage is sufficient until the temperature reaches 300 °C. At higher temperatures, it is advisable to adjust the temperature by adding a sufficient amount of current. At the same time, about 1 liter of distilled water was poured into the device to be steamed. When the temperature inside the device exceeded 800 °C, the device for steaming was connected to the current, adjusted to 72 volts, heated for approximately 30 minutes and steamed at a pressure of 10 atmospheres [8,9].

The properties of the obtained carbon dioxide and activated carbons as adsorbents can be determined to a certain extent by their total pore volume in water ($V\sum$), sorption pore volumes in water vapor, CCl_4 and benzene (VC_6H_6) and absorption of iodine (J_2) and methylene blue, etc.

The following parameters show the test results of carbon adsorbents pyrolyzed at 500 ^{0}C for 2 hours and steamed at 800 ^{0}C. This sample was found to absorb 3.313 mol/kg of benzene vapor when activated by steam, as tested by a McBen Bakra device, and it contained 99.5% C and 0.5% Ca ion when examined by SEM analysis.

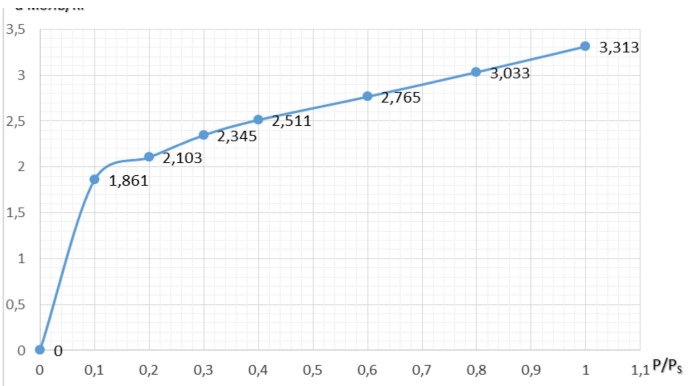

Figure 3. Test result of a sample subjected to pyrolysis at 500 °C and steam activated at 800 °C using a McBen Bakra device

Table 2.

Texture indicators of carbon adsorbent pyrolyzed at 500 °C and steam activated at 800 °C

adsorbent	a_m monolayer capacity, mol/kg	S comparative surface, S•10^{-3}, m^2/kg	W_s saturation volume, mol/kg
plum seeds	1,574	379,09	0,2936523

One of the main indicators of the adsorption process is a graph of the ratio of adsorbed substances (a) to relative gas pressure (P/Ps) at a constant temperature (T-const). The adsorption isotherm is found by the following formula:

$$a = \frac{1000}{Mr(C6H6)*(h-hx)}$$

P- pressure, mm.Hg.; *h*- extended spring length, mm; h_x- length of the spring stretched after the adsorption of the adsorbate on the adsorbent, mm; *a*- amount of absorbed adsorbent, mol; *P/Ps*- relative specific pressure, mm.Hg.

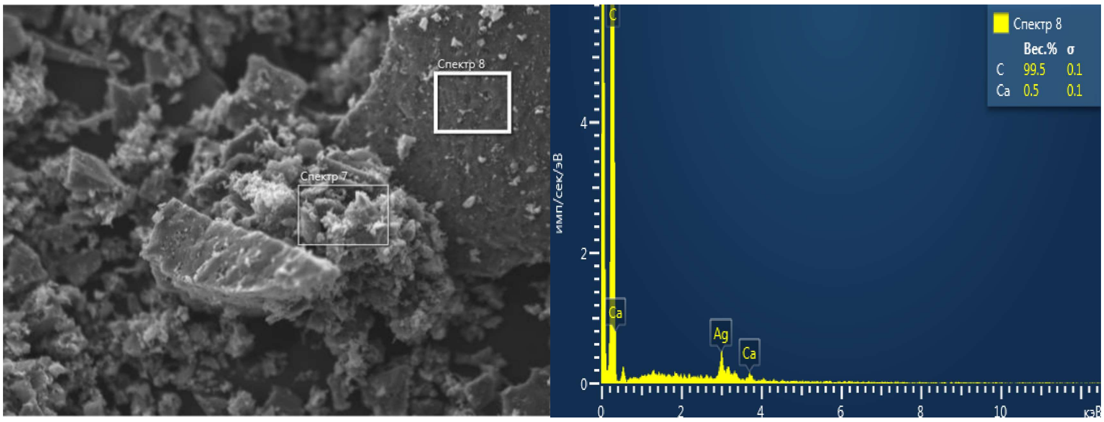

Figure 4. SEM analysis of the sample pyrolyzed at 500 °C and steamed at 800 °C

Conclusion. In this work, the physico-chemical parameters, adsorption activity, carbonization process and properties after steam treatment of activated carbons obtained on the basis of plum seed waste were studied. After thermal and steam treatment, the release of O_2 and Si elements in the grains causes an increase in the number of C and the adsorption properties of the obtained active carbons are high.

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ANALYSIS OF THE EFFECT OF ADHESIVE SUBSTANCES ON PAPER STRENGTH

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Abstract:
The article analyzes high-strength paper samples in the paper production process containing polyester (lavsan) fiber waste, including the introduction of adhesives into the paper cellulose together with synthetic waste fibers, the influence of the selected adhesives on the physical-mechanical and printing properties of the paper.

Keywords: cotton cellulose, polyester (lavsan), modified cationic starch (MCS), carboxyl methyl cellulose glue, acrylic emulsion (AE).

The pulp and paper industry is an industry related to wood processing. Currently, the world paper industry produces more than 800 types of paper and cardboard with different, completely opposite properties, the main raw material for the production of paper and cardboard in the world (more than 90%) is wood cellulose [1-5]. Taking into account the shortage of wood raw materials for Uzbekistan, the wide use of non-wood alternative raw materials of various herbaceous plants, annual plant waste, chemical and textile industries, and household waste for the production of paper products is promising [5-7].

Cotton pulp is the main and expensive raw material for paper production. The technology of paper production from cotton cellulose on an industrial scale does not have economic efficiency, but adding waste from the textile and chemical industry to paper pulp solves the problem of efficient and rational use of raw materials and saves valuable cotton cellulose. In the production of printing paper, the use of valuable cotton cellulose partially from the industrial waste with polyester (lavsan) fiber serves to increase the assortment of paper in the production of paper products at local enterprises, while reducing industrial waste in an ecological way, and at the same time, it makes it possible to determine in what proportions the use of secondary fibers is expedient [8 -10]. Obtaining sample papers and evaluating their quality was carried out in the test center of the Global Komsco Daewoo JV paper mill in accordance with the approved technological regulation. Samples containing cotton cellulose fibers and polyester (lavsan) fiber waste were taken in different proportions. Grinding of fibrous materials was carried out in Massroll-22.5 (Moscow). The degree of crushing of cellulose fibers was determined as 50-55° Shopper-Ringler. Samples were made on the sheet molding machine of the company "Rapid" (Germany). In order to obtain paper containing a certain part of cotton cellulose with polyester (lavsan) fiber waste, weighing ≈ 80 gr/m^2, cotton cellulose is crushed to 50-55 °ShR, then cleaned and cut into 2-5mm lengths of polyester (lavsan) fiber to prepare printing paper. mixed with waste. Additional fillers and adhesives were added to the composition of the paper pulp. The consumption of materials based on 1t of paper was as follows: Cotton pulp 0 - 100%; polyester (lavsan) fiber waste 2 - 50%; kaolin ($Al_2O_3 \cdot 2SiO_3 \cdot 2H_2O$) -145 kg/t; a mixture of tar acids containing rosin glue ($S_{20}N_{30}O_2$) -25.7 kg/t and $Al_2(SO_4)318H_2O$ consisting of aluminum sulfate, and rosin glues were used as adhesives. With the increase in the amount of polyester (lavsan) waste fibers in the cotton

cellulose, the bond strength between the fibers gradually decreased, the amount of intermolecular hydrogen bonds in the paper sheet decreased, and finally, the general properties of the paper deteriorated. [4].

The main goal of this scientific work is to obtain paper samples using modified cationic starch (MCS), carboxyl-methylcellulose and acrylic emulsion adhesives used in the paper production process in order to increase and stabilize the hydrogen bonding forces between the primary and secondary fibers in the paper pulp, and to determine the effect of these adhesives on the paper influence on physico-mechanical and printing properties (Table 1) was studied.

Research work was carried out in three stages. In the first stage, modified cationic starch (MCS) containing 80 percent of cotton cellulose, 20 percent of polyester (lavsan) fiber waste, in the second stage, carboxyl methyl cellulose glue and in the third stage, acrylic emulsion (AE) from 0.5 to 2.5 percent of the paper pulp. paper samples were taken by adding up to percent and the obtained paper samples were taken and compared.

In the first stage, the technological and economic feasibility of using modified cationic starch (MCS) was evaluated and their effect on paper strength parameters was studied. MCS is considered a high-quality component for printed materials, forming a thin film on the surface of the paper, improving the strength and resistance to external effects of the printed material, and is often used as a film-forming agent [5-10]. The effect of MCS on the mechanical properties of paper was studied. The obtained results show that in the process of obtaining MCS printing paper, the strength indicators of the paper increased by 5%. This can be explained by the interaction of the adhesive with cellulose fibers, the formation of hydrogen bonds with the cationic starch fibers due to the presence of anionic groups in fillers due to the mechanism of adhesion of small fibers to each other. It can be explained that the ash level of the experimental papers increased by 3 times, the filler, adhesive and synthetic fibers in the paper mass increased, and the whiteness level of the paper increased, and the whiteness level increased due to the better retention of kaolin and cellulose fine fibers by MCS glue. At the second stage, Na CMC sodium salt carboxymethylcellulose glue was used. Carboxymethylcellulose (CMC) is an acidic ester of cellulose and glycolic acid ON-SN_2-SOON. This ether is obtained in the form of sodium salt and is economically advantageous due to its low cost and easy availability. Na CMC were used as an adhesive in the paper composition in this scientific work. The obtained results helped to increase the strength properties of paper due to its unique physico-chemical properties, which are presented in the literature as a component of Na CMC paper pulp. It was observed that when the amount of NaKMTs in the paper increased by 2.5%, the strength properties increased up to 8%. In taking samples of Na CMC paper, despite the addition of 20% of polyester (lavsan) fiber waste, it was observed that the strength properties increased by 10%. Na CMC are more promising and effective due to their hydrophobicity, while significantly increasing the strength properties of paper.

At the third stage, paper samples were obtained by adding acrylic emulsion polymer adhesive compounds. Acrylic (polymethylacrylate) emulsion is an inconspicuous white liquid with a pH of 6.0-8.5, a relative viscosity of at least 1.75, and a mass fraction of monomer not exceeding 0.35%. 15% improvement in breaking length was observed when comparing paper samples containing acrylic emulsion to paper pulp and paper samples containing MCS and Na CMC glue. The expediency of using a new acrylic emulsion polymer glue instead of the traditionally used MCS and Na CMC glue was based on

the experimental method. Acrylic emulsion not only improves the mechanical performance of the paper, the optical properties of the paper and the whiteness of the paper have been increased by 12%.

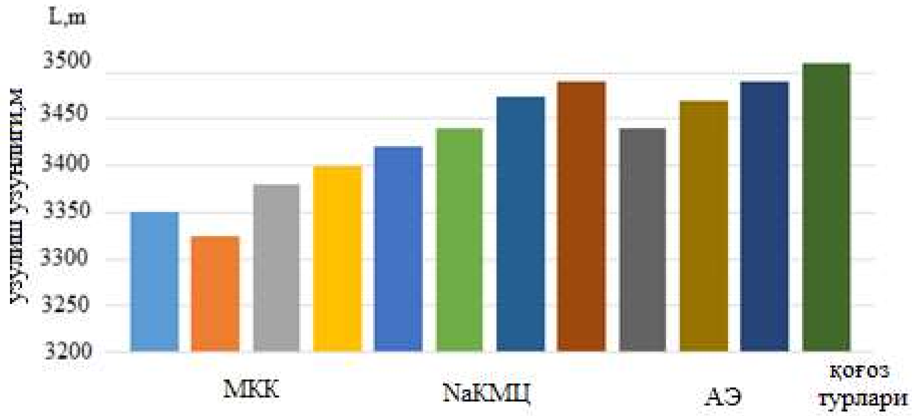

Diagram 1. Effect of adhesives on the breaking length of experimental papers

Table 1

The effect of adhesives on the physical and mechanical properties of experimental papers

Indicators / options	Adhesive substances: MCS				Na CMC				AE			
	1	2	3	4	5	6	7	8	9	10	11	12
The amount of adhesive in the paper mass, %	0,5	1,5	2,0	2,5	0,5	1,5	2,0	2,5	0,5	1,5	2,0	2,5
Cotton cellulose, %	100	80	80	80	100	80	80	80	100	80	80	80
Polyester (lavsan) fiber waste, %	-	20	20	20	-	20	20	20	-	20	20	20
Break length, m	3380	3375	3386	3395	3394	3398	3405	3408	3398	3404	3408	3412
Degree of whiteness, %	86	87	86	88	87	91	90	91	85	87	90	89
Breaking stress, N	31,0	31,5	32,8	33,0	32,6	32,8	33,4	34,2	32,6	33,3	34,7	34,9
Bending, i.b.s.	44	54	65	86	46	52	81	96	45	60	78	97
Ash, g	1,2	5,5	4,6	4,9	1,0	2,6	3,1	3,5	1,7	2,6	3,7	4,9

The obtained results revealed that the quality indicators of the paper samples were improved by 15%. It was found that the properties of polymer glue samples containing synthetic compounds correspond to the established standards and are as follows: polymer adhesives have the necessary adhesion to ensure a strong connection with the paper mass, give elasticity to paper samples, increase the breaking length.

Thus, it was determined that it is appropriate to use MCS, Na CMC and acrylic emulsion as adhesives in improving the strength indicators of paper samples. At the same time, the expediency of using a synthetic binder containing MCS, Na CMC and acrylic emulsion in increasing the quality of paper and cardboard samples (breaking length by 15%, optical indicators by 12%) was analyzed based on experiments. In this scientific work, paper samples with high strength are obtained during the process of paper production,

In conclusion it can be said that the method of obtaining paper, consisting of (80%) cotton cellulose and (20%) polyester (lavsan) fiber waste and chemically active (2-2.5%) adhesives, is proposed, in which cellulose-chemical dispersions of active adhesives create a high-strength bond between cotton cellulose and waste fibers, and the possibility of obtaining high-quality, high-quality paper with high strength clarified.

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UDK 665.6/.7: 662.6/.9

OPTIMIZATION OF HEATING OF MIXTURES OF OIL AND GAS CONDENSATE BY HOT FLOWS OF FRACTIONS IN TUBULAR HEAT EXCHANGERS

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Abstract:

Background of the problem. The constant increase in the cost of energy resources determines the search for ways to efficiently use thermal and electrical energy and thereby reduce production costs for the production of petroleum products. In this aspect, research aimed at improving the thermal efficiency of oil refineries by optimizing the technological modes of distillation of hydrocarbon raw materials is important.

Goal. Optimization of the process of heating mixtures of oil and gas condensate by hot flows of fractions in a tubular heat exchanger of an atmospheric oil distillation unit.

Methodology. Based on the mathematical model of the statics of thermal preparation (heating) of the oil and gas condensate mixture for distillation, the objective function of the optimality criterion is formulated - the specific technological cost of the heated mixture, which includes the cost of electricity for pumping raw materials and depreciation deductions for the heat exchanger and pump, depending on the parameters of the process. The computational and experimental study was carried out in accordance with the data of the technological regulations for the installation of atmospheric distillation of a mixture of oil and gas condensate of the Bukhara oil refinery (refinery).

Scientific novelty. A technique for optimal calculation and design of the process of heating local hydrocarbon feedstock - oil, gas condensate and their mixtures with pairs of light fractions in tubular heat exchangers of refineries is proposed, taking into account temperature changes in the properties of feedstock and coolant.

Received data. The process of heating the oil and gas condensate mixture in a horizontal shell-and-tube heat exchanger-condenser 10E-04 refinery, having a heat transfer surface of 243 m^2, formed from tubes with a diameter of 20/25 mm, was studied. The study was carried out at regulated flow rates of the working mixture of 105508 kg/h, within the temperature of its heating 96,1÷111,7 ^oC at the condensation temperature of vapors of common naphtha 136,6 ^oC. The results of the study of the process statics on the model showed that at a given plant capacity, the optimal temperature of the heated mixture at the outlet of the heat exchanger is equal to 107,3 ^oC, required heating surface of the device 178 m^2 and the minimum technological cost of the heated mixture is C_{ud} = 285,12 sum/kg.

Conclusion. Comparison of the identified optimal and regulated values of the design and technological parameters of the process indicated the insufficient use of the thermal power of the apparatus, which made it possible to formulate a compromise task - further increasing the flow rate of the mixture heated in the apparatus by 1.4 times or replacing it with a more compact heat exchanger, which will reduce costs while operation of the device.

Keywords: oil, gas condensate, hydrocarbon raw materials, distillation, fraction, naphtha, heating, condensation, heat exchanger, modeling, optimization, technological cost.

Introduction. As is known, the thermal preparation of hydrocarbon raw materials for distillation and rectification is characterized by high heat and electricity consumption. Therefore, with the constant growth of tariffs for energy resources, the operating conditions of large-capacity oil refineries at refineries do not always meet modern requirements for the efficient use of energy. This circumstance indicates the need to improve most of the technological processes of oil refining, including the

process of thermal preparation of raw materials for distillation, and to optimize the operating mode of the oil refinery.

According to the existing production technology at refineries, raw materials are initially heated in three blocks of tubular heat exchangers, then they are heated in a coil furnace, and then the raw materials are physically separated into fractions by distillation in an environment of superheated water vapor [1-5]. To heat the feedstock in the refinery, hot process streams leaving the distillation column are used - distillates of fuel fractions of naphtha, kerosene, diesel fuel and fuel oil [2-4].

As is known, tubular heat exchangers used for heating hydrocarbon raw materials are characterized by high operational reliability [2,4,5]. However, these devices are characterized by large weight and size parameters (diameter - 0,63÷1,8 m, tube length - 5÷10,6 m, weight - up to 35÷40 t) and low heat transfer efficiency (50÷100 W/m^{2}K) [4;6].

Therefore, further research aimed at the efficient organization of processes in heat exchangers and the refinement of methods for their optimal design, based on the principles of system analysis and mathematical modeling, which contributes to significant energy savings and operating costs, acquire important scientific and practical significance [6].

The purpose of this work is to determine the optimal design and technological parameters for heating hydrocarbon raw materials during the condensation of naphtha vapor in a tubular heat exchanger of an atmospheric oil distillation unit.

Research methods and techniques. The paper proposes a method for optimal calculation and design of the process of heating hydrocarbon raw materials with pairs of light fractions in tubular heat exchangers, taking into account temperature changes in the properties of local raw materials and coolant. This contributes to the development of energy-optimal designs of heat exchangers, a significant reduction in the technological cost of heated raw materials by reducing the consumption of heat and electricity for the process, as well as the synthesis of a rational scheme for the block of apparatus for thermal preparation of raw materials for an oil refinery [6-8].

This computational and experimental study was carried out in accordance with the data of the technological regulations for the installation of atmospheric distillation of a mixture of oil and gas condensate at the refinery [9]: the technical parameters of the industrial tubular heat exchanger-condenser 10E-04, the limit values of the mixture heating mode were determined (concentration of the mixture, flow rate of the mixture G_o and the heating flow of naphtha, the temperature of condensation of its vapors $t_{кн}$, the temperature of the initial $t_{вх}$ and the heated mixture $t_{вых}$) and indicators of the main properties of the mixture and coolant.

As is known, according to the existing method for calculating the heat transfer and heat transfer coefficients K in heat exchangers [4,6,10-12], the indicators of the physicochemical and thermophysical properties of the raw material and the heating agent (density ρ, viscosity ν and μ, heat capacity c, thermal conductivity λ, etc.) are taken at average values of their temperature t. However, the value of these indicators of hydrocarbon coolants depends on the value of the process temperature [1-3,6,11-13]. Therefore, taking into account the continuous change in the indicators of the properties of heat carriers from temperature, which forms the basis of the proposed method for calculating thermal coefficients in heat exchangers [6, 8], helps to increase the accuracy of the calculations performed by 20–30 %.

Based on the analysis of the phenomena that take place during the

heating of hydrocarbon feedstock in heat exchanger tubes [6, 7], a mathematical model of the statics of this process is obtained, which includes equations for changes in the temperature of the feedstock t along the length of the pipes l (1) and indicators of its properties - heat capacity (2) and density (3) during this process [7,14,15]:

$$
\begin{cases}
G_o\, d(ct)/dl = \alpha_2 \pi d_{vn} n\, (t_{st} - t), & (1)\\
\rho_4^t = 1000\rho_4^{20} - \frac{0{,}58}{\rho_4^{20}}(t-20) - \frac{|[t-1200(\rho_4^{20}-0.68]}{1000}\cdot(t-20); & (2)\\
c_p = 1{,}5072 + \frac{T-223}{100}\times(1{,}7182 - 1{,}5072\rho_4^{20}); & (3)\\
t \le t_{ogr}. & (4)
\end{cases}
$$

where G_o - consumption of hydrocarbon raw materials, kg/c; c - heat capacity of raw material at temperature t, J/(kg °C); $T = t + 273{,}15$ - raw material temperature, K; α_2 - heat transfer coefficient from the pipe wall to the heated liquid, W/(m^2.°C); d_{vn} - pipe inner diameter, m; n - number of tubes in the machine, per.; $t_{ст}$ - temperature of the inner surface of the pipe wall, °C; ρ_4^{20} - raw material density, kg/m^3.

The temperature limit of raw material preheating t_{ogr} is determined in accordance with the requirements of the technological regulations for the operation of an oil refinery [9] and the company's standards for the types of fuel fraction distillates produced - common naphtha, straight-run kerosene and diesel fuel. The tube wall temperature t_{st} depends on the temperature of the hot coolant - distillates of fractions in the liquid or vapor phases. The value of the coefficient α_2 is determined according to the refined method [8], using the temperature dependences of the properties of raw materials [6,13].

The process statics model (1-4) makes it possible to study the nature of the distribution of technological parameters for heating hydrocarbon feedstock along the length of heat transfer pipes l, to design heat exchangers with the optimal heating surface $F_{op} = \pi d_{vn} n l_{op}$, and also to analyze the degree of efficiency of operation of tubular heat exchangers operated at refineries at a given flow rate of raw materials and its heating temperature.

When solving the problem of optimizing the heating of hydrocarbon raw materials, either the rational boundaries of the technological parameters of the process or the minimum heat transfer surface of the apparatus, which provides its specified performance G_o, are determined.

To identify the optimal boundaries for heating oil feedstock with the heat of fractions, the technological cost of heated feedstock $C_т$ was chosen as an optimality criterion, which includes the cost of raw materials, heat carriers, heat and electricity, wages of maintenance personnel and other costs [6,19,20].

Since oil is not subjected to technological processing during heating, its cost C_o does not depend on the mode of operation of the heat exchanger. It should also be taken into account that the hot flows of fractions and fuel oil leaving the distillation column of an oil refinery are subject to cooling to their storage temperature [1-3]. Based on this, in order to improve the thermal efficiency of the oil refinery, these hot streams are used for sequential multi-stage heating of oil in heat exchangers. Therefore, the costs associated with the use of heat from hot streams do not affect the technological cost of the heated mixture $C_т$ in the apparatuses. In addition, the salary of technical personnel for maintenance of heat exchangers is fixed and it also does

not depend on the intensity of operation of the devices.

Taking into account the above circumstances, the costs associated with the purchase of raw materials, heat carriers and the salary of technical personnel are not included in the expression of the optimality criterion of the process under study. In this case, the objective function of the chosen optimality criterion - the technological cost of heating the oil feedstock - is formulated by us in the form [6,20]:

$$C_т = C_e\,(N_p+N_d) + F_a\,A_a + F_{kn}\,A_{kn} + (N_p+N_d)\,A_P. \qquad (5)$$

where, N_P and N_D - capacity of pumps for pumping oil and distillate fractions; C_e - cost of electricity; F_a and F_{kn} - heating surface of heat exchangers and condensers; A_a , A_{kn} , A_p и A_d - depreciation deductions for apparatus and pumps.

It is known that tubular heat exchangers in the raw material heating blocks of an oil refinery have different designs and performance [2,4,5]. Therefore, for the synthesis of the optimal composition of the heat exchanger block of the installation and its energy-saving technological scheme, it is advisable to take the specific technological cost of the heated raw material as an optimality criterion $C_{ud} = C_т/G_o$ [6,20]. In this case, (5) can be expressed as:

$$C_{ud} = 1/G_o[C_e(N_p+N_d) + A_aF_a + A_{kn}F_{kn} + A_н\,(N_p + N_d)]. \qquad (6)$$

A comparative assessment of the impact of the cost item on the technological cost of the heated mixture was carried out by analyzing the equations for calculating the parameters included in the expression of the objective optimality function (6).

Pump power N (kW) for pumping streams of crude oil and distillate fractions through the tubes of the heat exchanger is determined by the expression [10]:

$$N = [G_o\,0{,}5\upsilon^2\rho\,(\lambda n{\cdot}l\,/d_{ekv}+\Sigma\varphi)]/(1000\,\rho\,\eta_n), \qquad (7)$$

where, ΔP - hydraulic resistance of the pipeline for pumping flow, P; ρ - flux density, kg/m^3; η_n - efficiency pump; $\upsilon = 4G_o/(\pi d_{vn}^2\rho)$ - raw material flow rate in apparatus tubes, m/s; $\lambda = f(Re)$ - coefficient of friction, determined depending on the mode of flow in the tubes by the number Re [10]; $Re = (\upsilon d_{vn}\rho)/\mu$ - Reynolds number; μ - dynamic coefficient of viscosity of raw materials, Pa s; Σ - the total coefficient of local resistance in the apparatus and in pipelines to them [10].

The heat transfer surface F_a of the heat exchanger, taking into account its performance in terms of raw materials G_o, is determined by the expression [6]:

$$F_a = G_o\,(c_{вых}\,t_{out} - c_{in}\,t_{in})/(K\,\Delta t_{sr}), \qquad (8)$$

where, $G_o(c_{out}\,t_{out} - c_{in}\,t_{in})$ - thermal load of the device, W; c_{in} и c_{out} - heat capacity of raw materials at temperatures of its inlet to the apparatus t_{in} and at its outlet t_{out}, J/(kg·°C); K - heat transfer coefficient in the apparatus, W/(m^2 °C); Δt_{cp} - useful temperature difference between raw material and coolant, °C.

The value of depreciation deductions for the heat exchanger A_a and the pump $A_н$ depends on the duration of their operation T [6,20]:

$$A_a = (E_nЦ_a)/24\;T\;F\,, \qquad (9)$$

$$A_н = (E_nЦ_n)/24\;T\;N\,, \qquad (10)$$

where, $E_n = 0{,}15$ - normative coefficient of efficiency of capital investments in the industry; $Ц_a$ and $Ц_n$ - heat exchanger and pump cost, sum.

Thus, the objective function of the optimality criterion for heating a mixture of oil and gas condensate by the heat of the fuel fractions flow in a shell-and-tube heat exchanger is formulated as a system of equations:

$$\begin{cases} C_{ud} = 1/G_o\,[C_э\, N_n + A_a F_a + A_n N_n]\,; & (6) \\ \rho_4^t = 1000\rho_4^{20} - \frac{0,58}{\rho_4^{20}}(t-20) - \frac{|[t-1200(\rho_4^{20}-0.68]}{1000}\cdot(t-20); & \mathbf{(2)} \\ c_p = 1,5072 + \frac{T-223}{100}\times(1,7182 - 1,5072\rho_4^{20}); & (3) \\ N_n = [G_o\, 0,5\upsilon^2\rho\,(\lambda n{\cdot}l\,/d_{ekv} + \Sigma\varphi_l)]/(1000\,\rho\,\eta_n); & (7) \\ \quad F_a = G_o\,(c_{out}\,t_{out} - c_{in}\,t_{in})/(K_{kn}{\cdot}\Delta t_{sr}); & (8) \\ \quad A_a = (E_n Ц_t)/24T\,F; & (9) \\ \quad A_n = (E_n Ц_n)/24T\,N; & (10) \\ t \le t_{ogr}. & (4) \end{cases}$$

Constraints (6) in the area of the study of the objective function are set by the temperature of the heated mixture at the outlet of the heat exchanger $t_{out} \le t_{ogr}$ [9].

The solution of the above system of equations (2-10) is reduced to identifying the optimal boundaries of the technological regime for heating the oil and gas condensate mixture in the heat exchanger-condenser 10E-04, operating in the mode of efficient use of the heat of condensed naphtha vapor.

Research results and discussion. The statics of the process of heating the oil and gas condensate mixture, consisting of 30 % oil and 70 % gas condensate, by the heat of condensing vapors of the total naphtha fraction, leaving the upper parts of the columns for the preliminary fractionation of raw materials and atmospheric distillation of oil at the Bukhara Oil Refinery, was studied.

The industrial heat exchanger-condenser 10E-04 used for heating the working mixture has the following design parameters [9]: d = 20/25 мм, l = 6,0 м и n = 644 per, and its heating surface in size d_{vn} is F_{vn1} = 243 m^2.

The heating of the mixture in the tubes of this apparatus was studied at the following values of the technological parameters of the process [9]: G_o = 105508 kg/h, ρ_{20} = 768 kg/m^3, t_{in} = 96,1 ^{o}C, t_{out} = 111,7 ^{o}C and t_{kn} = 136,6 ^{o}C. The calculated value of the heat transfer coefficient from the pipe wall to the mixture is α_2 = 878 W/(m^2·K), and the value of the heat transfer coefficient in the apparatus is equal to K = 270 W/(m^2· K).

Based on the results of the study of the process on a mathematical model, a distribution curve of the heating temperature t of the oil and gas condensate mixture along the length of the tubes l of the heat exchanger was constructed for a given performance G_o (Fig. 1).

It can be seen from Figure 1 that at a given flow rate of the working mixture G_o = 105508 kg/h its temperature t in the heat exchanger smoothly rises to 107,3 ^{o}C with increasing speed at a pipe section $l \le$ 4,4 м. At the same time, the rate of rise in the temperature of the mixture along the length l in the initial section is 2,6 ^{o}C/m, and closer to the temperature equilibrium point - 3,5 ^{o}C/м. In the future, with the achievement of a constant temperature difference between the oil and gas condensate mixture and the coolant, the rate of change in the temperature of the mixture along the remaining length of the pipes (up to 6.0 m) becomes unchanged.

Analysis of the curve $l = f(t)$ shows that the main process of heating the oil and gas condensate mixture to the required temperature $t_{вых}$ = 107,3 ^{o}C takes place in the initial section of pipes with a length of $l \le$ 4,4 m, which is 63.7 % of the total length of the tube bundle in apparatus, and the rest of the tubes in the bundle runs idle (section from 4.4 to 6.0 m). Whence it follows that with a given productivity of the

apparatus G_o = 105508 kg/h of the mixture, its required heating surface is F_2 = 178 m^2. Comparison of the values of heat exchange surfaces F_1 = 243 m^2 ≥ F_2 = 178 m^2 indicates insufficient use of the heat output of the apparatus. It follows that the 10E-04 heat exchanger-condenser has a reserve for further increase in the flow rate of the mixture heated in it by 36.4 % (1.36 times).

Subsequently, the objective function of the optimality criterion for heating the oil and gas condensate mixture (2-10) in this apparatus was studied in relation to the operating conditions of the atmospheric oil distillation unit of the Bukhara Oil Refinery [13]. The calculation of the objective function of the optimality criterion according to (6) was carried out with the above values of the process parameters - G_o, G_d, t_{in}, t_{out} and t_{kn}.

Based on the results of the calculations, curves were plotted for changes in the components of the specific cost of heating the working mixture C_{ud} in the heat exchanger (sum/kg) - depreciation deductions for the heat exchanger (curve *1*) and the cost of pumping liquid by the pump (curve 2), depending on the temperature of the mixture t_{out} at t_{out} = 96,1÷111,7 °C and condensation of total naphtha vapor t_{kn} = 136,6 °C (Fig. 2).

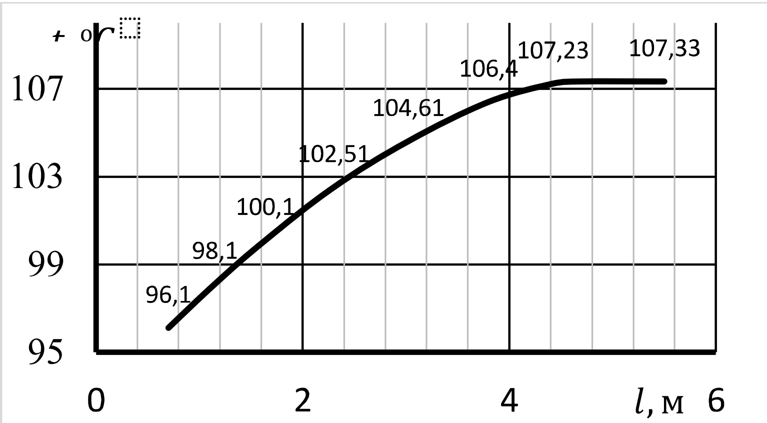

Fig. 1. Distribution of the heating temperature of the oil and gas condensate mixture *t* along the length of the pipes *l* of the 10E-04 heat exchanger at its flow rate G_o = 105508 kg/h

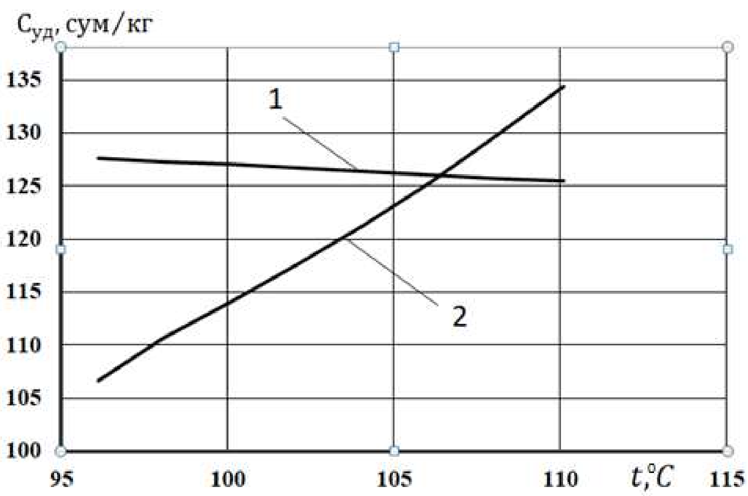

Fig. 2. Change in depreciation deductions for heat exchanger *1* and costs for pumping oil and gas condensate mixture *2* depending on the temperature of its heating t_{out}

Analysis of the values of the components of the unit cost of the heated working mixture C_{ud} is as follows. According to the calculations, the amount of depreciation deductions for the heat exchanger $A = A_aF_a$ (curve *1*), depending on the mode of operation of the heat exchanger, intensively increases along an inclined curve from 106.66 to 134.39 sum/kg. To pump a given amount of the mixture Go = 105508.3 kg/h through the tubes of the apparatus and the process pipe adjacent to it, N_n = 15,4 kW of power will be required. Taking into account the cost of electricity for the refinery C_e = 440,52 sum/kW and depreciation of pumping equipment, the total costs for pumping a given flow rate of the mixture $Э_n = N_n(C_e+A_n)$ drops from 127.62 to 125.45 sum/kg (curve 2). In our opinion, the point of intersection of curves *1* and 2, where the values of the parameters F_2 = 178 m^2, $Э_n$ = 125,58 sum/kg, A = 127,55 sum/kg, C_{ud} = 285,12 sum/kg and t_{out} = 107,3 °C, characterizes the optimal operating conditions of the 10E-04 heat exchanger-condenser at its given productivity G_o = 105508,3 kg/h.

Conclusion. Thus, according to the results of studies on the model of the statics of heating the oil and gas condensate mixture, the optimal design and technological parameters of the process in the heat exchanger-condenser 10E-04 with a capacity of G_o = 105508 kg/h were revealed: mixture heating temperature t = 107,3 °C, device heating surface F_{vn1} = 178 m^2 and mixture heating cost C_{ud} = 285,12 sum/kg. Comparison of the working heating surface of the apparatus F_1 = 243 m^2 with its optimal value F_2 = 178 m^2 indicates insufficient use of its thermal power, which also allows solving a compromise problem - further increasing the consumption of the heated mixture in the apparatus up to 1.4 times or replacing it with a more compact heat exchanger. Such a solution helps to improve the operating conditions of the apparatus, reduce operating costs and develop energy-efficient technological schemes for heat exchangers of the feedstock heating unit of an oil refinery.

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BINDING MATERIALS FOR CREATING COAL GRANULES AND THEIR COLLOID-CHEMICAL CHARACTERISTICS

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Abstract. This article examines binders necessary for formation of coal-resin granules and their colloidal-chemical characteristics. Data analysis shows that viscosity and coke residue are key parameters for binders. Optimum viscosity values ensure the required plasticity of the mixture for granulation, and a coke residue content of 9-15% contributes to the formation of carbon bridges without reducing adsorption activity.

High viscosity adhesives such as asphaltene and bitumen require the use of solvents to reduce viscosity. The use of auxiliary substances, such as heavy gas oil and diesel fuel, makes it possible to obtain formulations with low viscosity and optimal coke residue content.

Keywords: Coal, carbon bridges, coke, viscosity.

Introduction. The correct choice of binder in the coal granulation process is an important factor in obtaining a highly efficient coal adsorbent. The binder influences the structure and properties of the resulting material, which directly affects its adsorption capacity [1, 2]. It promotes the formation of a dense and porous granule structure, which provides a large contacting surface and increases the adsorption efficiency [3-5].

Most of the binders used in the production of granulated active coals are not Newtonian fluids due to the presence of supermolecular structures. Viscosity is highly dependent on the group composition of the product. For example, the presence of resins and asphaltenes leads to increased viscosity, while paraffin-based hydrocarbons and monocyclic arenas contribute to its reduction [7-9].

The viscosity and coke residue content (BC) [16] are the key characteristics of the binder, which provides for the forming of the coal and binder compositions into the granules and their strength during subsequent thermal modification. The optimum viscosity values

of the binder ensure the necessary plasticity of the composition: coal+binder. If plasticity is insufficient, an uneven distribution of the coal powder in the binder and a disruption of the pelletizing process through the die is possible. The coke residue content in the binder is normalized at about 15 mass percent. Low coke residue content (less than 10%) may result in insufficient carbon bridge formation during heat treatment, which will not provide the required pellet strength in the final coal. On the other hand, the high coke residue content (more than 15-17%) can lead to coagulation of the pores of the sorbent and, as a consequence, to a decrease in its adsorption activity [12-15].

The aim of the study is to establish the composition of binders for the creation of granulated coal adsorbents on the basis of the results of the study of viscous characteristics and coke residue of the binder system.

Objective and methods. Commercial coal tar (KB) (Chemistry and Technology, LLP, Kazakhstan) and residual oil products of «Fergana Refinery» LLC asphalten and construction bitumen were chosen as the binder for coal pellets production.

In this paper, dynamic and conditional viscosity of investigated binders were investigated. The HSN-3 rotary viscometer was used to measure dynamic viscosity. The principle of the instrument is to measure the force required to rotate one element of the measuring geometry relative to another. In order to assess the variation of dynamic viscosity over time under constant conditions, measurements were made within three hours.

The quantitative determination of the BC is carried out in accordance with the requirements of GOST 22989-78 when choosing a binder for the production of activated carbon.

Results and discussion. The quality and viscosity characteristics of the binders used in the studies are given in table. 1 and 2.

Table 1.

Physical and chemical indicators of binders

Sample	Density, sm^3/g	Humidity, %	Ash content, %
Coal tar	1,15	3,6	0,10
Asphalten	1,08	1,4	0,12
Bitumen	1,11	0,9	0,56

Table 2.

Viscosity properties of resins

Sample	Kinematic viscosity, sPz		
	50 ºC	65 ºC	80 ºC
Coal tar	159,2	68,8	33,3
Asphalten	448,3	189	58,6
Bitumen	211,2	86,5	39,3

A high content of coke residue can cause negative consequences. A high concentration of coke can lead to the formation of undesirable slag inclusions and make it difficult to achieve the optimal granule shape [17–20]. Higher amounts of coke can contribute to increased dust generation and losses during pellet handling and transport. Therefore, it is necessary to balance the content of coke residue in the binder in accordance with the quality requirements and the goals of activated carbon production. The data obtained are given in table. 3.

Table 3.

Quantity KO, %

Coal tar	Asphalten	Bitumen
21,5	18,6	13,1

According to GOST 22989-78, coal tar has the highest carbon residue value at a lower viscosity at 50ºC. This means that when using this resin in a composition with coal, it is possible to achieve the lowest energy costs for the formation of a homogeneous mixture and granulation with increased mechanical strength of coal granules. Since the amount of carbon residue, composition uniformity and viscosity affect the strength of the coal pellets, based on scientific findings, it can be argued that the use of coal tar with a high carbon residue content at optimal viscosity contributes to the production of pellets with increased mechanical strength. However, when the content of the coke residue of the binder material is more than 20%, a decrease in the adsorption activity of the finished granules is observed. This is explained by the fact that an increased amount of coke residue can lead to clogging of the pore structure of coal.

Changes in the viscosity of mixtures during the preparation of granules may be due to temperature control. Therefore, it is important to investigate the effect of temperature on this process. For binders such as asphaltene and bitumen, which are characterized by high viscosity, it is difficult to achieve a homogeneous composition of coal and binder to form granules. Therefore, these binders require the use of solvents to reduce their viscosity. As a result of the use of such binders, two-component mixtures were obtained, in which auxiliary substances were used, such as heavy gas oil ((TG) KO=5.41%) and diesel fuel ((DF) KO=2.15%) (Table 4).). Samples were mixed at a temperature of 80ºC to obtain a homogeneous mixture on a UTAS-0195 laboratory mixer.

Table 4.

Variation of viscosity and coke residue values depending on the composition of the binder mixture

Compound, №	Component content, %					Dynamic viscosity, Pa*s		KO, %
	KS	AF*	BT**	TG	DT	40ºC	80ºC	
1	80	-	-	20	-	43,32	6,86	18,3
2	80	-	-	-	20	34,21	5,51	17,6
3	-	70	-	30	-	18,24	2,43	14,6
4	-	70	-	-	30	15,51	1,96	13,7
5	-	-	70	30	-	31,31	3,12	10,7
6	-	-	70	-	30	28,75	2,18	9,8

**- asphaltene;*
***- bitumen.*

The table lists the most promising binder compositions in which it is possible to obtain optimal values of viscosity and CO.

The composition 1 has an asphaltene (AF) content of 20% and the COP component and 80%. The dynamic viscosity at 40 ºC is 49.32 Pa*s and the coke residue (BC) content is 18.3%, while the composition 2 differs as a result of 20% DT instead of AF. The dynamic viscosity of the mixture at 40 ºC is 43.21 Pa*s and the coke residue content is 17.6%.

Composition 3 contains 70% AF and

30% heavy gas oil (TG). The dynamic viscosity of this composition at 40 ºC is 18.24 Pa*s, and the coke residue content is 14.6%, and the composition 4, which is distinguished by the auxiliary substance DT, is characterized by dynamic viscosity values at 40 º C of 15,51 Pa*s, and the coke residue content is 13.7%.

Formulations 5 and 6 consist of 70% bitumen (BT) and 30% sweat TG and DT, respectively. More viscous is the composition 5, and its coke residue is 10.7% versus 9.8 for the composition 6.

Compositions No. 1 and No. 2 are the most viscous systems with a dynamic viscosity at 40ºC of 49.32 Pas and 43.21 Pa*s, respectively. This indicates their higher plasticity and formability for the process of preparing granules of coal-tar compositions.

The content of coke residue in compositions No. 1 and No. 2 is 18.3 and 17.6%, respectively. However, it should be noted that these values exceed the recommended range of 9% to 15%. A higher content of coke residue can lead to clogging of the pores of the carbon adsorbent, which can potentially reduce its adsorption activity. Thus, it is important to consider this factor when choosing formulations for further research.

Compositions No. 3 and No. 4, containing heavy gas oil (TG) and diesel fuel (DF) as auxiliary substances, have a lower dynamic viscosity and coke residue content. This may indicate the potential of using these compositions to reduce viscosity and prevent clogging of the carbon adsorbent pores.

Compositions No. 5 and No. 6, consisting of bitumen (BT) and TG or DF, also have a lower viscosity and coke content. They may be of interest for further research in order to optimize the process of preparing granules and obtaining carbon adsorbents with desired characteristics.

In general, in order to select the most promising compositions for further study of their adsorption and strength characteristics, it is necessary to take into account both the viscosity and the content of the coke residue in order to achieve optimal results in the process of preparing coal adsorbent granules. Therefore, compositions Nos. 3, 4, and 5 were chosen for further studies, which are characterized by the most appropriate values of coke residue and dynamic viscosity.

The study also analyzed the change in the viscosity of these compositions during their storage at elevated temperatures. Observations have shown that with time the viscosity of these mixtures (Fig. 1) practically does not change, even at elevated temperatures. The increase in viscosity during storage at constant temperature and shear stress is no more than 10-13% of the initial value. These results confirm the promise of using these mixtures to create a coal + binder composition.

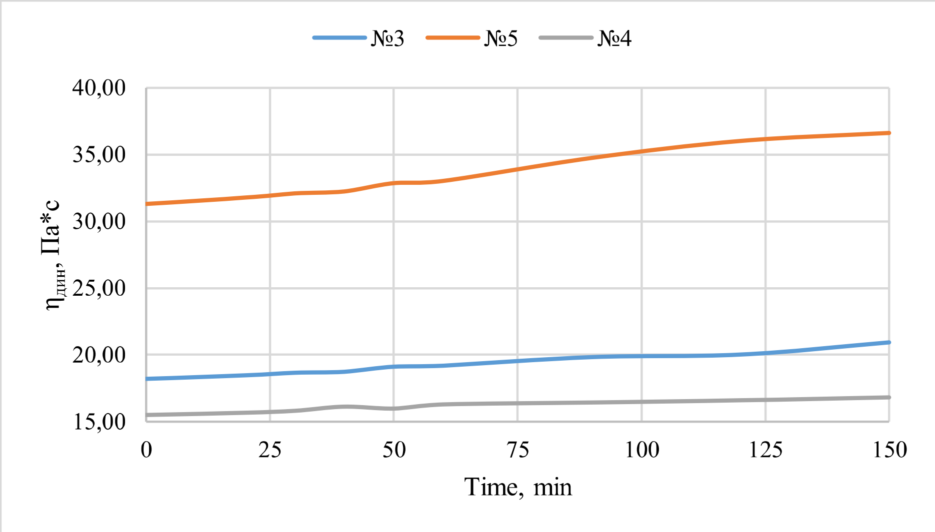

Fig. 1. Change in the viscosity of the mixture of binders from the duration of storage

Data analysis shows that all three formulations show some changes in viscosity during storage. It is important to note that changes in viscosity depend on the composition of the binder and its interaction with other components.

It can be assumed that the viscosity changes are associated with the composition of the binders. Comparing compositions Nos. 3, 4 and 5, it can be seen that asphaltenes are the basis for compositions Nos. 3 and 4, while bitumen is the basis for composition No. 5. Bitumen and asphaltenes have different chemical structures and properties, so their interaction with other components may be different.

In the case of composition №5, which contains bitumen, there is a more significant increase in viscosity over time. This may be due to physico-chemical processes, such as polymerization or oxidation of bitumen, which can lead to an increase in viscosity.

Formulations №3 and №4 containing asphaltenes do not show such a significant change in viscosity over time. Asphaltenes generally have a more stable structure and are less prone to viscosity changes than bitumen.

Conclusion. From the analysis of the data obtained, it follows that the key characteristics of the binder material for the formation of coal-tar granules are the viscosity and the content of the coke residue. Optimum viscosity values provide the plasticity of the mixture necessary for granulation. The content of the coke residue in the range of 9-15% ensures the formation of carbon bridges and does not reduce the adsorption activity.

High viscosity binders such as asphaltene and bitumen require the use of solvents to reduce the viscosity. The use of auxiliary substances, such as heavy gas oil and diesel fuel, makes it possible to obtain compositions with low viscosity and carbon residue content.

The study also showed that the viscosity of the created (No. 3, 4 and 5) compositions practically does not change during storage at elevated temperatures. The increase in viscosity is less than 10-13% of the original value. This indicates the prospects of using these mixtures for the formation of coal-tar granules. Thus, the selected binder compositions have the potential to create carbon granules with desired characteristics, and further research will be directed to the analysis of their adsorption and strength properties.

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UDC: 665.6/7

ANALYSIS OF OIL DUST RELEASED DURING PROCESSING OF METAL SURFACES UNDER LABORATORY CONDITIONS

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Abstract:

Objective. In this article, in the process of metal surface treatment, in order to cover the metal surface, in laboratory conditions, the process of processing metal heated to a high temperature using motor oils is studied.

Methods. A laboratory device was used to study this process. Oil-containing gases obtained in laboratory conditions have been studied.

Results. The results obtained were compared with the allowable concentration of gases. Absorption cleaning is recommended to retain gases in excess of the permitted rate. The results obtained with the proposed new device were analyzed.

Keywords: metal, oil dust, absorption, metallurgy, gas concentration, concentration, absorber, mass transfer coefficient.

Introduction. The activation of technological processes in ferrous and non-ferrous metallurgy, chemistry, mechanical engineering and other industries in practice serves to increase production volumes, improve quality and reduce costs [1]. These processes mainly use compressed gases, especially air, oil products [2,3,4]. The purification of oil-containing gases emitted into the atmosphere as a result of oiling the metal surface by the absorption method is considered effective. Separation mass transfer processes are widely used in industry and are carried out mainly in column-type apparatuses. Gas mixtures

separate For swallowing process wide used [5]. Absorption - gases or couples choose to swallow process gas phase liquid absorbers. Liquid cleaning tool dust swallow what is called. Gas mixtures was swallowed up component absorbent what is called [6]. Physical and chemical processes underlie the technology of oil refining. Calculation, design and control of such processes require knowledge of the physical and chemical properties of oil, gas condensate and their mixtures [7] . In this case, waste gases are formed that are released during the production process. And the resulting gas is purified by the absorption method. Harmful and toxic gases emitted by an enterprise may vary depending on the type of production and the substances used by it. Depending on the characteristics and physico-chemical properties of each off-gas emitted, different types of treatment equipment must be used. For example, off-gases, separated from oil-containing gases, are cleaned by the absorption method, and dry dust is separated by cyclones.

Methods. Experimental equipment was created to study the process of capturing oil dust emitted into the atmosphere and its absorption into the environment in metallurgical and metalworking enterprises. The schematic diagram of the equipment is shown in Figure - 1.

The experimental setup (Fig-1) includes a smoke blower *1*, an oil evaporation oven *2*, a thermometer for measuring the temperature of the attached liquid *3*, a heater for evaporating the evaporated liquid *4*, evaporating liquid *5*, thermometer for measuring the temperature of the generated flue gases *6*, chimney *7*, glass monometer for measuring hydraulic resistance *8*, valve *9*, rotameter for measuring gas volume flow *10*, for atomizing the gas that has passed through the rotametric nozzle *11, absorber 12* for purification of generated smoke, absorber *13* , nozzle for increasing the gas surface *14*, gas analyzer for measuring the concentration of SA in the purified gas *15*, valve for draining waste liquids *16*, branch pipe for the outlet of purified gas *17*, temperature controller of the absorber consists of a rheostat 18 for adjusting the temperature of the spiral, coils 19 for heating the absorber, regenerator 20 for regenerating the spent absorber.

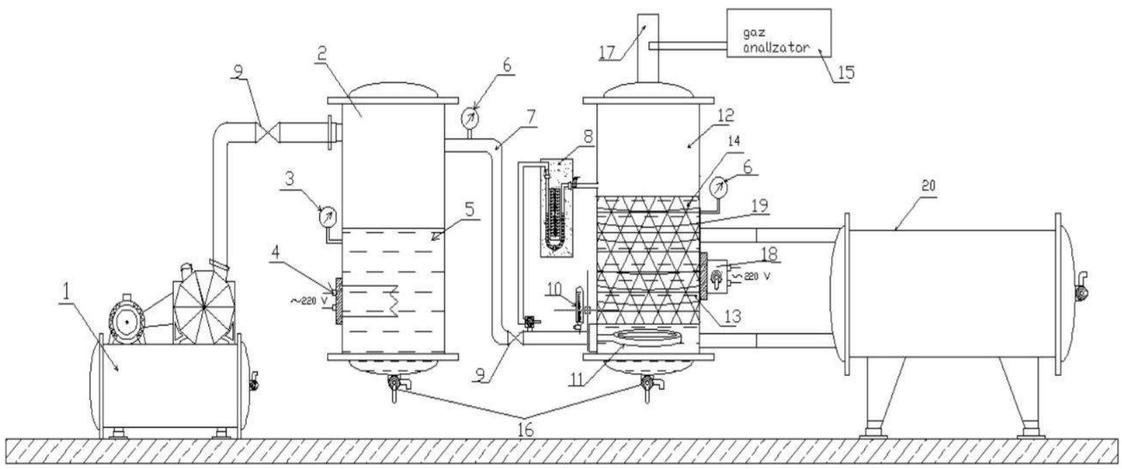

Figure 1. _ Scheme of the experimental setup for studying the absorption process

1-compressor; *2*-evaporator; *3.6*-thermometer (LATR); *4*-electric skin; *5*-oil; *7*-pipe; *8*-pressure gauge; *9*-valve; *10*-rotameter; *11*-nozzle; *12*-shock absorber; *13*-absorbent; *14*-nozzle; *15*-gas analyzer; *16*-valves; *17*-pipe; *18*-rheostat; *19*-spiral; *20*-regenerator

The experimental setup works in the following order. *5 evaporating* liquids (T-750, I-20, OE-26) are poured into *2* containers with a volume of 8 liters. The liquid is heated to a temperature of 300-600 ℃ after *4* tens. The temperature of the resulting smoke is measured by three thermometers. 1 compressor is connected to the steam transmitter to supply smoke to 12 absorbers at the required speed and pressure. To control the parameters of the smoke supplied to the absorber, the chimneys 9 are equipped with valves. The resulting smoke is sent to 12 absorbers through 11 barbarians. The smoke bubbler passes through the absorber 13. The purified gas that has passed through the absorbent is discharged through pipe 17. Gas analyzer 15 (GX-3R Pro) was used to measure the concentration of purified smoke. 20 are sent to the regenerator to clean the absorber. The temperature of the absorber is controlled by an 18-wire coil.

To place the nozzle on the device, a nozzle tower is made from it and placed on the device.

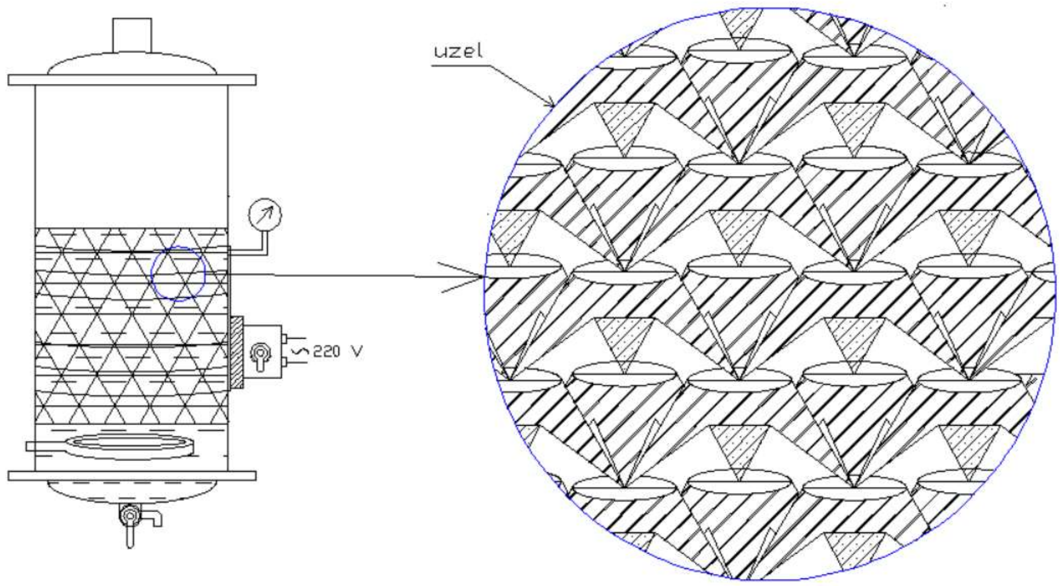

Figure 2. Packed tower to absorber placed appearance

Nozzle tower from the absorber passable gas effect surface increase to work out, to the nozzle to be sent gas effect surface increase to work designed. Before the start of the experiment, the mass of the substances used was measured on an electronic balance model CAS WM' 3000. After the experiment, the used substances are removed from the device. The content and weight of used oil and absorbent are continuously measured. The measurement also takes into account the operating time of the absorbent.

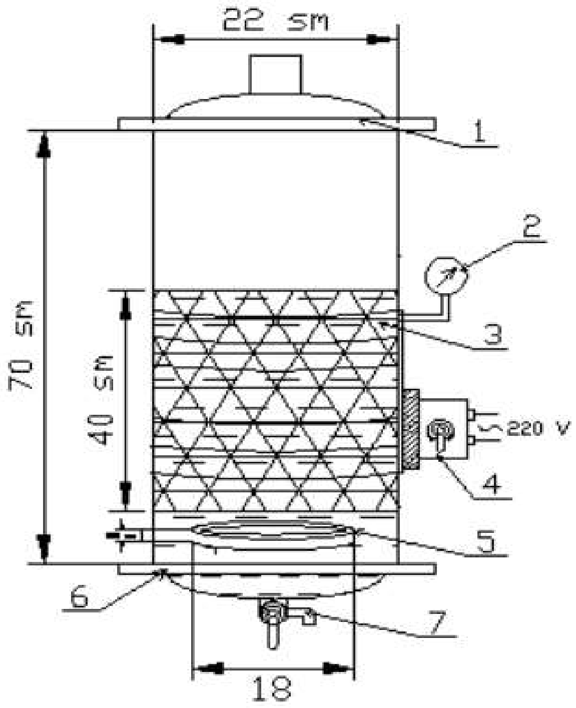

Figure 3. 1.6-cap, 2-thermometer, 3-nozzle, 4-electric tank, 5-bubbler, 7-faucet

The experiment in fig. 2 The absorber is assembled for the main geometrical dimensions of the absorption device as follows: device diameter D=22 cm, height H=70 cm, nozzle height (changes) h=20...50 cm, barbater Diameter d_1 = 18 cm, d_2=10 cm. The device is designed for the absorption process. A cylindrical metal case and additional devices necessary for the process are connected to it. The body of the absorber 1 consists of a gas holder 3, a monometer 2 connected to it, an electric heater for temperature control 4, a bubbler 5 for passing gas, a cover 6 and a valve for draining liquid 7.

The device works as follows. The gas passed through the bubbler 5 interacts with the absorbent through the nozzle 3 and is ejected after mass transfer. The device temperature is controlled by 4 electric heaters. The pressure in the device is measured by two manometers. The absorber dimensions are calculated depending on the gas volume flow. The nozzle mounted on the absorber is specially designed for gas distribution, and through this device the gas passing through the barbattery is evenly distributed throughout the volume.

The laboratory device was tested for volume flow (Q=0,08 m^3/s) · Optimization is done to change the consumption and adjust to the normal operation of the device.

There are different types of gas distribution nozzles, and each nozzle is selected depending on the working environment and operating conditions of the device. Suggested nozzle lined up in one row.

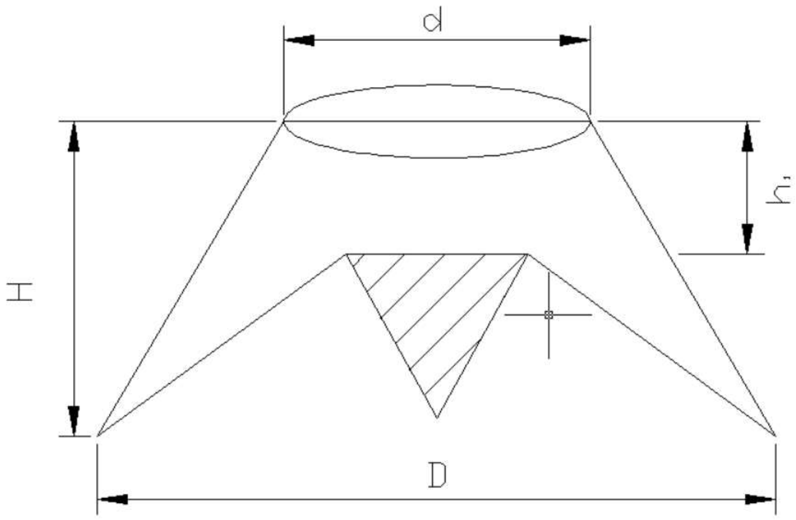

Figure 4. Overview of the nozzle and placed on the device. Figure - 4 shows the proposed nozzle. The nozzle size is the optimal size based on experience

The calculation of the proposed packing is mathematical and is determined experimentally . Taking into account the fact that the nozzle has a conical shape and is made by separating the conical parts, the calculation of the nozzle is based on the calculation of the cone. First, the total volume and the equivalent nozzle diameter were determined. Used from it except the nozzle free size and get wet coefficient experience way with determined. The results will have the following meaning. A three-base nozzle with a size of 66*66*40 has a comparative surface δ=65 m ^{2}/m^3, free volume v=0,07 m^3/m^3, equivalent diameter d_e=0,0043 m.

Obtained results based on nozzle mass transfer coefficient when determined. Offer made nozzle efficiency to compare for, 50*50*5 people and conical nozzle mass transfer coefficient knocked down.

This for each one nozzle constant pressure and geometrical dimensions one another in the absorber test was carried out. Nozzle height is also equal in the case received one absorber mass transfer coefficient was determined. The mass imparting coefficient is the main one of the parameters considered. it is the process of urine and gas phase between being a physicist chemical processes represents. Physics processes for important was phases little by little effect showing the main value is considered. This for the following consider works to take went [8]. According to the following formula, the nozzle mass to give the coefficient is determined:

$$Kxf = \frac{1}{\frac{1}{\beta xf} + \frac{1}{m\beta xf}} \qquad (1)$$

Here K_{xf}- mass transfer coefficient, b_{xf} -gas in phase mass transfer coefficient, m - degree indicator, *0.05-4.6* h equals. [9,10,11].

Results. The massing according to the obtained results is shown in Figure 5.

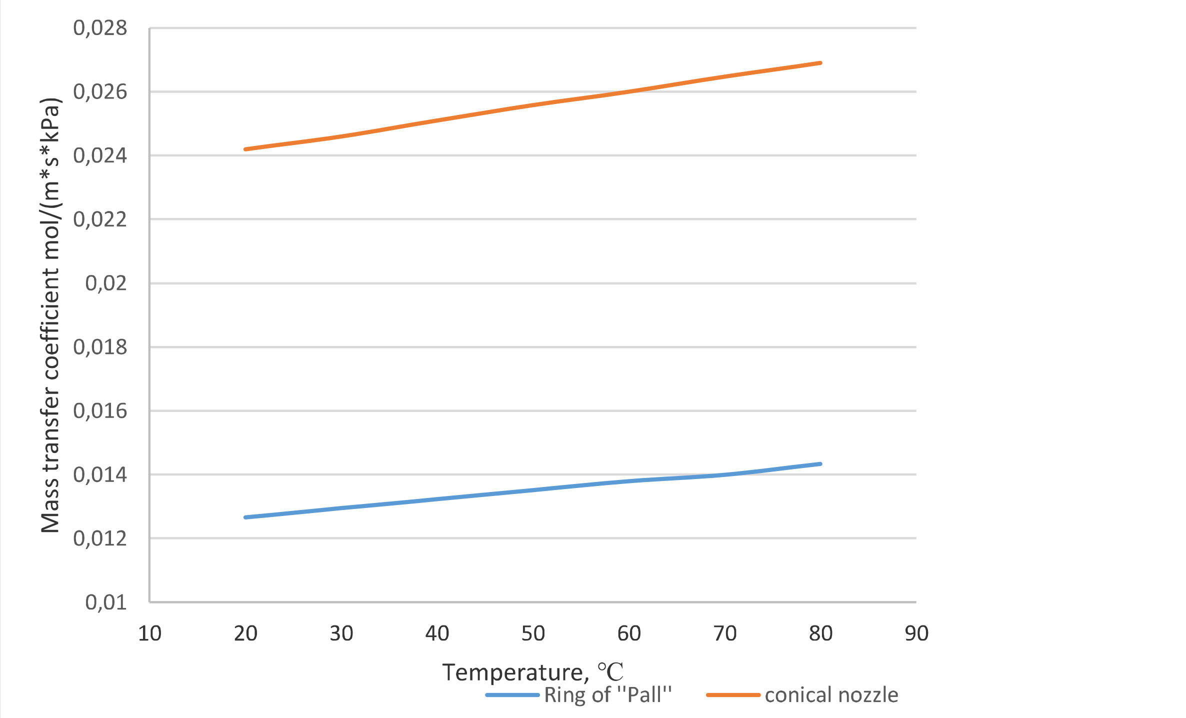

Figure 5. The conical nozzle and the scheme of your rings give a coefficient to the temperature depending on without gas

Conducting mass ratio of each single nozzle shape, type, nozzle made substance characteristics depend experience 20 ℃ in the working ring when you go mass transfer coefficient 0,01266 $\frac{mol}{m*s*kPa}$to equal the point that has been determined. At the same temperature, the mass transfer coefficient in the proposed conical nozzle is 0.0242 $\frac{mol}{m*s*kPa}$ equal to the fact that it was determined. Obtained results based on the mass to give a coefficient based on the effectiveness of the indicator definition can be this for the following from the formula was used

$$K_{kf} = \frac{N1-N2}{N1} \qquad (2)$$

Here K_{kf} - efficiency coefficient, N_1 - conical nozzle mass give a coefficient of 0.0242, N_2 -Pall ring mass give a coefficient.

At 20 ℃ mass transfer coefficient I do not know at 47.68% under development high brotherhood has been determined. Set the temperature to 60℃ while increasing the mass transfer Pall coefficient is 0.013 $\frac{mol}{m*s*kPa}$ equals it happened Tapered in the nozzle until this figure is 0.026 $\frac{mol}{m*s*kPa}$ equals the fact that was determined.

Discussion and analysis. The experience has been transferred, that's all, it shows that the high viscosity in liquids will have a conical nozzle that will have a large efficiency. From this, in addition to the conical nozzle, the washable gases contained mechanic additives are also effective separate can. To this reason, the conical in the nozzle of the mechanic of the addition catches to remain flat on the surfaces of his absence. neat placed confusion in the nozzle of the mechanic adding the device to the bottom drowned without a separate is taken. The experience of high viscosity was

transferred to have in industrial oil OE-26 went to take. Process physicist absorption method to do the process is considered.

Conclusion. Summary when doing so to say, now the high-temperature operating devices of the heavy machine industry, asphalt work to produce factories, food cooking in their branches to heat up as a result of other oil and organic supplements separate out. It is organic oily powders at low temperatures condensation as a result of the surroundings to the environment and the industry of the enterprise that's all determined from the norms of applause goes. These oil cleaning for absorption process is considered to be effective. Above in the article in the industry separable greasy dust laboratory method of harvest, made and environmental standards based cleaning for an efficient device, the proposal is made. Oils are an efficient cleaning to ensure that the absorption from the process has been used. Absorbers work performance to increase for the conical nozzle was created. Its effectiveness has been compared with. Comparison as a result of the new nozzle work performance of 47.68% (mass. give coefficient on) to the same thing that was determined. The suggestion made by the device greasy dust absorption in the process of an effective device is that the above from experience own confirmation found.

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UDC 621.372.632

STUDY OF FOAM FORMATION IN POLYMER SOLUTIONS DEPENDING ON THE CONTENT AND NATURE OF SURFACTANTS

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Abstract:

Objective. In this article, the influence of the content and nature of surfactants on the process of foaming in polymer solutions was studied. As a result of the experiment, it was found that the stability of the foam in the polymer system corresponds to the content of surfactants and their foaming properties. Particularly stable foams are formed when using surfactant OP-10 at concentrations of more than 0.3%. When using these surfactants in drilling fluids, their concentration can reach 1-2% or more, so the foam formed can be very stable over time. In addition, the kinetics of foam destruction in polymer drilling fluids with various surfactants can vary significantly depending on the structure and nature of the surfactants used. It was also found that the concentration of surfactants in the solution and the presence of salt ($CaCl_2$) significantly affect the kinetics of foam formation and destruction. In general, the study results make it possible to effectively control the process of foaming in polymer solutions and use the knowledge gained to optimize technological processes in various industries.

Methods. The use of biopolymers for the preparation of drilling fluid reduces the environmental impact, as biopolymers are susceptible to attack by microorganisms and most acids. As a result, biopolymers decompose to complete oxidation. The biopolymer XanFlex was used as the basis for the preparation of the polymer drilling mud.

Results. As shown in the table, the polymer drilling mud containing about 1.5% of the polymeric structure forming agent is characterized by specific viscosity (T) values of about 36 s. It has a good filtration index (V, cm^3/30). The density is increased to 1.11 (ρ, g/cm^3) due to the presence of calcium chloride. It forms a thin imperceptible transparent crust which contains a polymer mesh with $CaCl_2$.

Conclusion. The life span of the foam in systems of polymers with different surfactants varies and the stability of the foam in the system corresponds to the content of surfactants and their foaming properties.

Keywords: foaming, defoaming agent, surfactant, OP-10, GKZH-11, adsorption, surface tension, polymer solution, Glamin.

Introduction. Process water is the most accessible and cheapest cleaning agent in the drilling process. It can be suitable for drilling fairly stable rocks [1, 2]. The use of water as the drilling fluid contributes to the achievement of high mechanical speed. However, in terms of the ability to carry out cuttings, water is

much inferior to clay drilling fluids. Especially, water cannot keep cuttings in suspension in the absence of circulation. Therefore, at present, water is used only for drilling shallow wells (up to 30–50 m) [3–5].

The advantages of water as a drilling fluid can also include the absence of clogging of the productive zone of the solid phase of the drilling fluid. Nowadays, drilling fluids without a solid phase have become widely practiced instead of clay drilling fluids, i.e. polymer drilling fluids [6-10]. Many years of experience in this area has shown that these types of drilling fluids have high technological characteristics. The use of these solutions provides high drilling speed; they have good bearing capacity due to high values of dynamic shear strain.

Due to the low content of the solid phase or its absence, the wear rate of the drilling tool is reduced and these solutions are indispensable when drilling a productive horizon.

However, in the absence of a solid clay phase, polymer drilling fluids easily foam and the resulting foam remains for a long time. Therefore, when using these types of drilling fluid, the issue of defoaming agent is acute [11-20].

Therefore, the purpose of these studies was to study foaming in polymer solutions depending on the content and nature of surfactants.

Methods. The use of biopolymers for the preparation of drilling fluid reduces the environmental impact, as biopolymers are susceptible to attack by microorganisms and most acids. As a result, biopolymers decompose to complete oxidation. The biopolymer XanFlex was used as the basis for the preparation of the polymer drilling mud.

Experimental part. To obtain polymer drilling fluids, Glamin was used as a structure forming agent in an amount of 0.5%. The content of the main polymer XanFlex was 0.7-1%. Salt $CaCl_2$ in the amount of 3% was used as an inhibitory additive.

The characteristics of drilling fluids were established according to the requirements of State Standard R 56946-2016 (ISO 13500:2008).

Results and its discussion. The drilling fluid obtained in this way has the following technological characteristics (Table 1).

Table 1

Technological characteristics of polymer drilling fluid based on XanFlex and Glamin

T, c	P, мPa*c	pH	B, cm^3/30 c	Peel thickness, mm	CHC_1/CHC_{10}, дПа	ρ, г/cm^3
43	8,5	8	5	0,2	9/13	1,11

P-plastic viscosity, B- fluid loss

As shown in the table, the polymer drilling mud containing about 1.5% of the polymeric structure forming agent is characterized by specific viscosity (T) values of about 36 s. It has a good filtration index (V, cm^3/30). The density is increased to 1.11 (ρ, g/cm3) due to the presence of calcium chloride. It forms a thin imperceptible transparent crust which contains a polymer mesh with $CaCl_2$. The use of this formulation with the addition of a weighting agent to obtain the required density values provides high structural-mechanical, filtration and rheological characteristics of the polymer solution. The use of a low-density solution makes it possible to prevent the fluid loss, caving and to preserve the natural permeability of

productive formations to the maximum extent. This type of drilling fluid, due to the content of clay swelling inhibitor salt and Ca^{2+} ions, can be successfully used for drilling clay rocks, various salt and carbonate deposits.

Further, the processes of foaming in polymer solutions were studied. The obtained data are shown in fig. 2.

Without surfactants, when blowing air, polymer drilling fluids form foams no more than 5 cm, which is lower compared to the results of clay BR. Studies of the kinetics of foaming in a polymer drilling fluid system with the addition of XanFlex and Glamin show that the rate of foam formation depends on the concentration of XanFlex in the fluid, temperature, pressure and mechanical impact on the fluid. In the early stages of foaming, there is a rapid increase in foam volume, which then slows down to a stable concentration.

The kinetics of foam formation can be described by the foam growth equation, which has the form:

$$dV/dt = k * C^n * P^m$$

in that form **V** means the volume of foam, **t** is time, **C** is the XanFlex concentration, **P** is pressure, **k** is the rate constant, **n** and **m** are the degree of dependence of the rate on concentration and pressure, respectively.

It has also been found that the kinetics of foaming can be changed by adding foam inhibitors or changing the pH of the solution. These methods can reduce the rate of foam formation and improve drilling efficiency.

As can be seen from fig. 1, the intensity of foaming in the system of clayless drilling fluids is much higher compared to clay fluids at the same concentrations of OP-10.

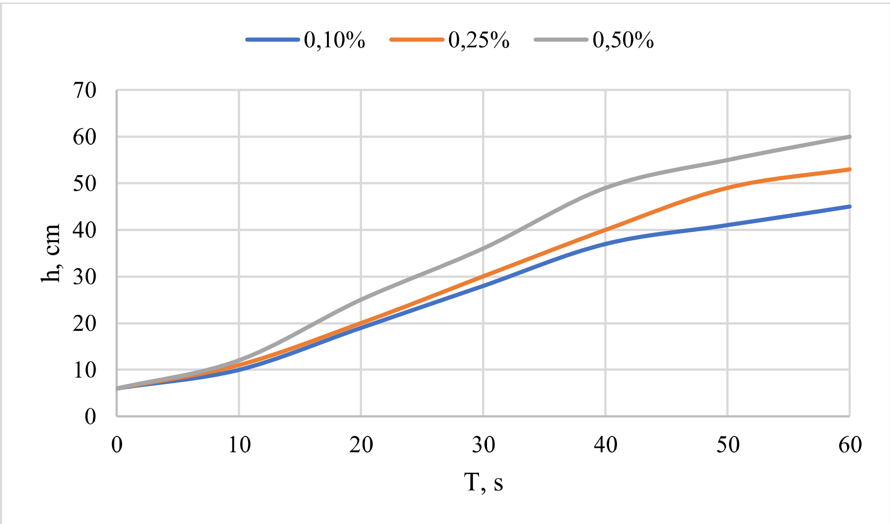

Fig. 1. Kinetics of foam formation in polymer drilling fluid with OP-10

This can be explained by the fact that the system does not contain a solid phase that would prevent the formation of foam. At the same time, a certain amount of surfactant is consumed for adsorption on clay particles; thereby its amount at the liquid/air phase boundary decreases several times. Therefore, in a system without solids, the amount of adsorption at the interface is much lower compared to clay drilling mud and the total foam volume is much larger.

The kinetics of foam formation in an aqueous solution of the OP-10 reagent can be described as a process that depends on many factors, such as reagent concentration, temperature, pressure, the presence of other additives, and mechanical influences on the solution. When adding reagent OP-10 to water, the

formation of the smallest microparticles occurs, which are quickly distributed over the volume of the solution. Under the action of mechanical influences, for example, when shaking or stirring, the microparticles begin to combine into bubbles, which then make foam.

The rate of foam formation depends on the concentration of the OP-10 reagent in the solution, since with an increase in concentration, the number of microparticles increases, and, consequently, the number of bubbles in the foam. The temperature also affects the rate of foam formation: with an increase in temperature, the rate of foam formation increases, since the moving force of the molecules increases and the probability of microparticles joining into bubbles increases.

Another factor affecting the foam formation kinetics is the presence of other additives in the solution. For example, the addition of salts can slow down the rate of foam formation, since salts can compete with the OP-10 reagent for the surface of the microparticles and reduce the possibility of their aggregation into bubbles.

Thus, the kinetics of foam formation in an aqueous solution of the OP-10 reagent is a complex process that depends on several factors and can be described by mathematical models that take these factors into account.

Practically similar results were also obtained for the system with GKZh-11. As previously established, the foaming capacity of this system is significantly lower compared to OP-10. However, in a system without a solid phase, surfactant GKZH-11 demonstrates almost the same foaming characteristics (Fig. 2).

Almost identical foam volume values in systems with different surfactants indicate the same surface activity. Probably, when using GKZH-11 in a clay suspension, the main part of the surfactant used to bond with the clay surface due to the high affinity with the clay surface. Therefore, the volume of foam in this system may have had lower values.

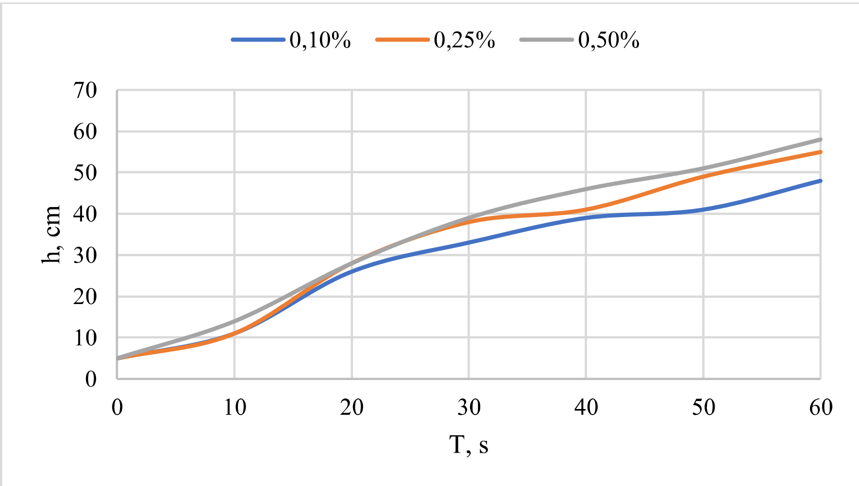

Fig. 2. Kinetics of foam formation in polymer drilling fluid with GKZh-11

Therefore, when using polymer drilling fluid in practice, the possibility of facing problems associated with foaming is much greater. Probably, the greater volume of the foam is due to its stability. Therefore, the use of these systems requires the introduction of a larger amount of defoaming agent, because due to the foaming of the drilling fluid, its density somewhat decreases, due to this, the back pressure in the formations decreases and the rheological parameters deteriorate.

At low surfactant concentrations at the beginning of the foam generation

process, the foam height is almost the same for both systems. However, after 10 seconds of blowing air into the system, there is a sharp increase in foam volume, especially at higher surfactant concentrations (0.5%). When air is blown for 20 seconds or more, the height of the foam in the system with GZhZh-11 at concentrations of more than 0.5% reaches more than 30 cm after a minute of generation, while for a concentration of 0.1%, the height is only 24 cm.

If the difference in the volume of clay drilling fluid with 0.5% OP-10 and GKZh-11 was more than 1.36 times, then polymer solutions with these surfactants form 60 and 58 cm of foam per minute. Similar values of the foam height in systems with different surfactants indicate that the mechanism of their interaction and surface activity at the interface is practically the same. Further blowing and shaking do not lead to significant changes in the height of the foam, but affect its stability.

The life span of the foam in systems with different surfactants varies. The stability of the foam in the system corresponds to the content of surfactants and their foaming properties. Systems with OP-10 at concentrations greater than 0.3% are more stable. Considering that the concentrations of these surfactants in the drilling fluid system can reach 1-2% or more depending on the characteristics and conditions of the drilling fluid, the resulting foam can be very stable over time (see Figures 3 and 4).

The kinetics of foam destruction in polymer drilling fluids with various surfactants can vary significantly depending on the structure and nature of used surfactants. OP-10 and GKZH-11 have different structures, different types of surfactants have different chemical structures, which can affect their ability to form and break down foam. Depending on the structure, some surfactants may have surfactant properties that result in a more stable foam, while other surfactants may have a faster foam breakdown rate.

The concentration of surfactants in solution can significantly affect the kinetics of foam formation and destruction. Generally, as the surfactant concentration increases, the rate of foam destruction decreases. The kinetics of foam formation and destruction will also be affected by the presence of salt ($CaCl_2$), which can accelerate foam destruction.

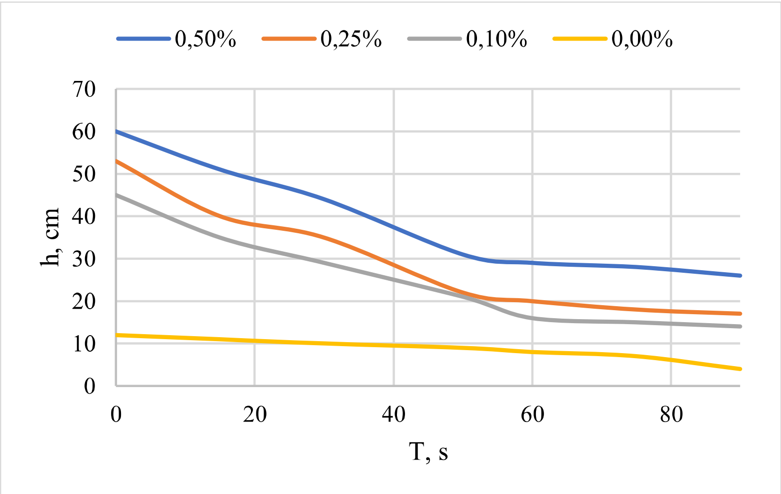

Fig. 4. Kinetics of foam destruction in polymer drilling fluid with OP-10

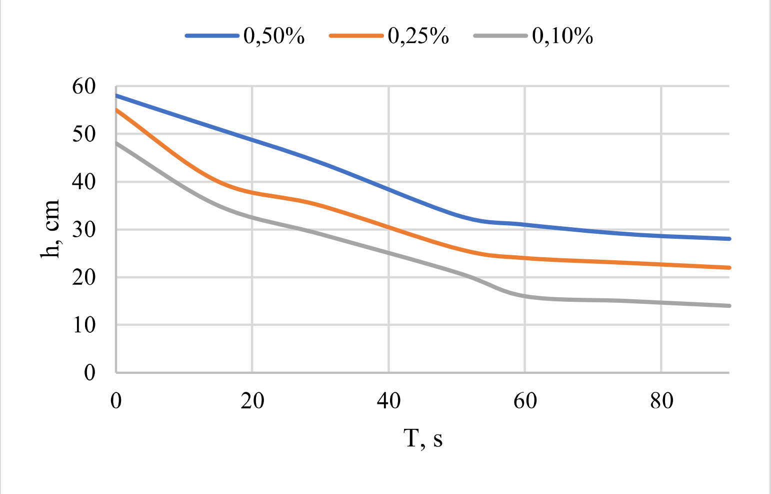

Fig. 5. Kinetics of foam destruction in polymer drilling fluid with GKZh-11

In general, the kinetics of foam destruction in polymer drilling fluids with various surfactants can be very complex and depend on many factors.

From the description of the data, it can be concluded that the kinetics of foam destruction in the system with OP-10 exhibits a decrease in foam height in two stages. First, there is a gradual decrease in foam height over 30 seconds, followed by a sharp decrease in foam height from 44 to 31 cm over the next 20 seconds, followed by stabilization of the total foam volume.

On the other hand, in systems with GKZH-11, foam with a height of 4-5 cm is retained even after 10 minutes of settling, with a content of GKZH-11 of more than 0.2%. This indicates more effective foam retention in the system with GKL-11, which may be due to its hydrophobic properties and the ability to form more stable foam in the system.

For complete destruction of the foam in systems with surfactants, it will take about 30-60 minutes, while for systems without them, about 2 minutes are enough. It can be concluded that the change in the ability of surfactants to form foam and the duration of its existence in the drilling fluid system depends on the nature of these surfactants, and the stability of the foam correlates with their adsorption properties at the water-air interface.

Kinetics of foam destruction may differ in systems with nonionic and ionic surfactants. Nonionic surfactants generally have surface active properties, making them good foam stabilizers. At the same time, they have a low electrolyte character and do not interact with ions in solution. As a result, kinetics of foam destruction in systems with nonionic surfactants can be more stable and slower than in systems with ionic surfactants.

On the other hand, ionic surfactants have surface-active properties and a chemical structure that allows them to interact with ions in solution. This can lead to a change in the surface charge of the foam bubbles and a change in the kinetics of its destruction.

Thus, the kinetics of foam destruction can vary significantly depending on the type of used surfactants.

Conclusions. The life span of the foam in systems of polymers with different surfactants varies and the stability of the foam in the system corresponds to the content of surfactants and their foaming properties. Systems with OP-10 at concentrations greater than 0.3% are more stable, and at concentrations of these surfactants in the drilling fluid system, which can reach 1-2% or more, the resulting foam can be very stable over time. The kinetics of foam destruction in polymer drilling fluids with various surfactants can

vary significantly depending on the structure and nature of the surfactants used. The concentration of surfactant in the solution can significantly affect the kinetics of foam formation and destruction, and the presence of salt ($CaCl_2$) can also accelerate the destruction of the foam.

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UDC 621.372.632

FREQUENCY ADJUSTMENT OF WELL PUMPING EQUIPMENT

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Abstract:

Objective. improve energy efficiency by adjusting the frequency of well pumping equipment.

Methods. Frequency adjustment, thermal image management, analytical analysis, energy-efficient operating modes of pumps, reliability indicators.

Results. Based on equations (1) - (42) in the MatLab/Simulink program, the simulation model of the "Autonomous voltage inverter - asynchronous electric motor with a short-circuited rotor - centrifugal pump" system was developed.

Conclusion. This computer model confirmed the hypothesis that it is possible to reduce the energy consumption of the well pumping system by adjusting the rotation frequency of the electric motor rotor by adjusting the supply frequency in scalar systems of frequency converters at the same mains frequency..

Keywords: Frequency adjustment, asynchronous motor, water supply system, well pumping equipment, electric drive, computer model, MatLab/Simulink.

Introduction. It is effective to use frequency-adjustable electric drives in automated control systems (ACS) of well pumping equipment to adjust the operating mode of the well pump to the operating mode of the delivered liquid supply system, for example, the network of an industrial enterprise.

Industrial water consumption is constantly changing depending on process requirements. Water consumption is determined by the laws of random-probability. Constantly adjusting the operating mode of the pumping equipment to monitor such changes increases efficiency.

The adjustment process is complicated by the imbalance between well pumps connected directly to the network and water consumption. The characteristics of well pumps are that as water consumption increases, the pressure developed by the pump in pipelines decreases. On the contrary, with a decrease in water consumption, the pressure in pipelines increases. Therefore, in periods of reduced water consumption, water supply systems create excess pressure. To keep the pressure in the supply systems at the same level, it was done by changing the number of pump units, changing the opening level of the valves in the pipelines, or adjusting the speed of the pump unit. The most effective of these is adjusting the speed of the pump unit [1].

The development of the water supply system includes the use of frequency converters and specialized control algorithms that can maintain the pressure

level set in the supply network within certain limits [2]. In addition, by adjusting the "asynchronous motor - pump - pipe" system based on electric drive with a frequency converter, it helps to optimize the pressure in the water network and reduce the probability of pipe breaks [3].

The purpose of this research work is to develop a method for evaluating the energy saving potential by reducing excess water pressure and electrical losses when adjusting the operation modes of the pump equipment based on the frequency converter.

Methods. According to the information in the article [4], 58.9% of the produced water is consumed due to the demand of the technological process, and the remaining 41.1% is wasted (Fig. 1). In this regard, the average amount of water produced per day is 65.5 m3·h, of which 38.6 m^3·h is used for consumption, and the remaining 26.9 m^3·h is discharged into the sewage pipeline. The reason for the waste of produced water is the unevenness of the water consumption regime, and this method is used to adjust the pressure in the pipe.

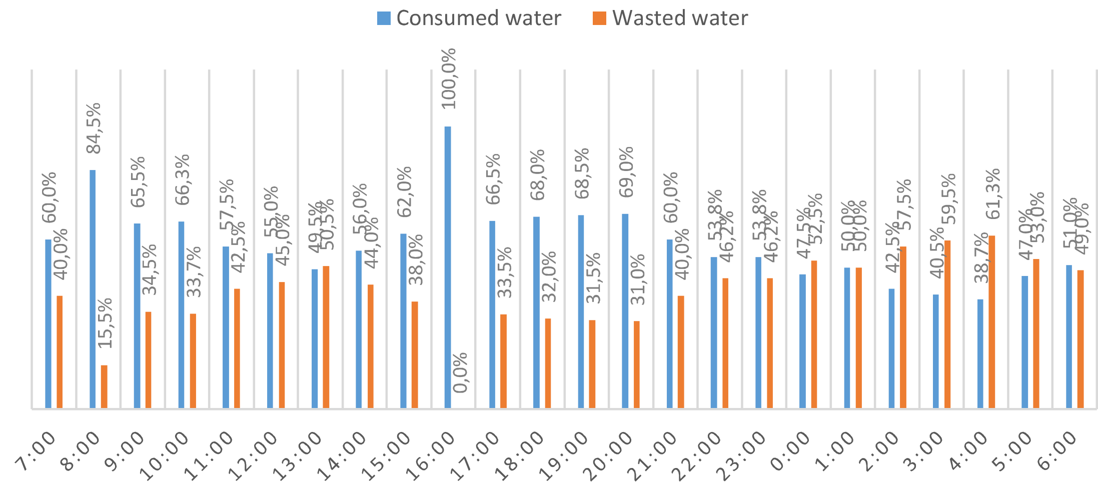

Figure 1. Consumption of produced water for 1 day

One of the ways to increase the energy efficiency of well pumps is to maintain optimal pressure in the pipeline. To determine the required pressure created by the pump, the depth of the pump in the well in the working state, the diameter of the pipe, the static H_{st} and dynamic H_{d} water level in the well and the geometric height of the water rise H_g are determined as follows:

$$H = \left(H_g - H_d\right) + \Delta H, \tag{1}$$

The energy efficiency of well pump equipment is realized due to adjustment of their operating modes based on automation, frequency converter and specialized control algorithms. When adjusting the rotation speed of the system, the pressure characteristics of the pump are described by the quadratic parabola equation [5]:

$$H(Q) = H_x \cdot (\omega/\omega_{nom})^2 - S_x Q^2, \tag{2}$$

where: H_x – imaginary head of the pump at zero efficiency, m, in the absence of data for clean water $H_x = 1{,}25 \cdot H_{nom}$; ω, ω_{nom} – variable and nominal angular velocity of the pump drive, rad/s; S_x – is the imaginary hydraulic resistance of the pump, $m \cdot (h/m^3)$.

The imaginary resistance of the pump can be determined according to the formula (2) at the nominal capacity, pressure and pump speed:

$$S_x = \frac{H_{nom} - H_x}{Q_{nom}^2} = \frac{H_{nom} - 1{,}25 \cdot H_x}{Q_{nom}^2}, \qquad (3)$$

where: Q_{nom} – nominal flow of the pump, $m^3/soat$.

The pressure characteristic of the pipeline network is described by the quadratic parabola equation using the following formula[6]:

$$H(Q) = H_g + S_q Q^2 \qquad (4)$$

where: S_q – hydraulic resistance of the pipeline network, $m \cdot (h/m^3)$:

$$S_q = \frac{H_g - H_{nom}}{Q_{nom}^2} \qquad (5)$$

At the intersection of the pressure characteristics of the pump and the pipeline network, a steady state is formed, which determines the actual operation and pressure of the pump unit. The solution of the system of equations (2) and (4) allows obtaining the hydraulic characteristics related to the angular velocity of the electric drive. The real roots of the equation determine the working area of the pump:

$$H(\omega) = \frac{S_x H_g + (\omega/\omega_{nom})^2 S_q H_x}{S_x + S_q}, \qquad Q(\omega) = \sqrt{\frac{H_g - (\omega/\omega_{nom})^2 H_x}{S_x + S_q}}. \qquad (6)$$

The entire range of the angular speed change of the electric motor $\mu_{m.nom}$ and the efficiency of the frequency converter μ_{VFD} remains close to the nominal, and the hydraulic efficiency of the pump varies according to Moody's formula [7]:

$$\mu_n(\omega) = 1 - \frac{1 - \mu_{n.nom}}{(\omega/\omega_{nom})^{0.36}}. \qquad 7)$$

where: $\mu_{n.nom}$ – nominal hydraulic efficiency of the pump.

Energy efficiency to reduce excess pressure in water lifting

Nominal pressure $H_{nom} = 150\,m$, productivity $Q_{nom} = 63\,m^3/soat$, efficiency $\mu_{n.nom} = 0.84$ and rotation speed $n_{nom} = 2919\,ayl/min$ ($\omega_{nom} = 305{,}522\,rad/s$) Consider the operation of a well pump in a direct supply system. Nominal parameters of the electric motor: power $P_{nom} = 45\,kW$; efficiency $\mu_{m.nom} = 0.84$; overload volume $\lambda = M_{max}/M_{nom} = 2.2$; moment of inertia $J = 0.1\,kg/m^2$. Annual water consumption – $Q_{yil} = 109090\,m^3$, maximum hourly water consumption $Q_{max} = 68\,m^3$.

As a result of the hydraulic calculation, the required water pressure $H_g = 65\,m$ according to (1) was determined, which reduces the excess pressure of the water rising into the pipe system: $\Delta h = \Delta H_1 - \Delta H_2$. An explanatory diagram of the water supply network is shown in Fig. 2.

Reducing the pressure (points 1 to 2 in the diagram in Fig. 2) reduces the head from Q_{nom} to Q_r by changing the speed of rotation of the pump wheel in accordance with the pressure characteristic (2) and therefore it is set in the hours of maximum water consumption 'indicators must be observed:

$$Q_r \geq Q_{max}. \qquad (8)$$

The angular velocity of the motor can be obtained by solving equation (6) with a known thrust or pump supply:

$$\omega_r = \frac{\omega_{nom}\sqrt{S_q H_x (S_q H_r - S_x H_g + S_x H_r}}{S_q H_x} \qquad (9)$$

The limiting angular velocity Q(ω), which determines the stable operation of the pump, is found by solving (6) equation [6, 7, 8]:

$$\omega_b = \omega_{nom}\sqrt{H_g/H_x}. \qquad (10)$$

Thus, it follows from the possible control ranges that the frequency control conditions can be met:

$$\omega_r \geq \omega_b \text{ va } \omega_r \geq \frac{2\pi f_{min}(1-s)}{p}, \qquad (11)$$

where: f_{min} – minimum permissible power frequency during pump operation, Hz; s, p– the number of slips and pairs of poles of the motor.

The actual power, kW, used for the rise of water at a certain angular speed of the pump is determined by the following formula[6]:

$$P(\omega) = \frac{\rho \cdot Q(\omega) \cdot H(\omega)}{3600 \cdot 102 \cdot \mu_n(\omega) \cdot \mu_{n.nom} \cdot \mu_{VFD}} \qquad (12)$$

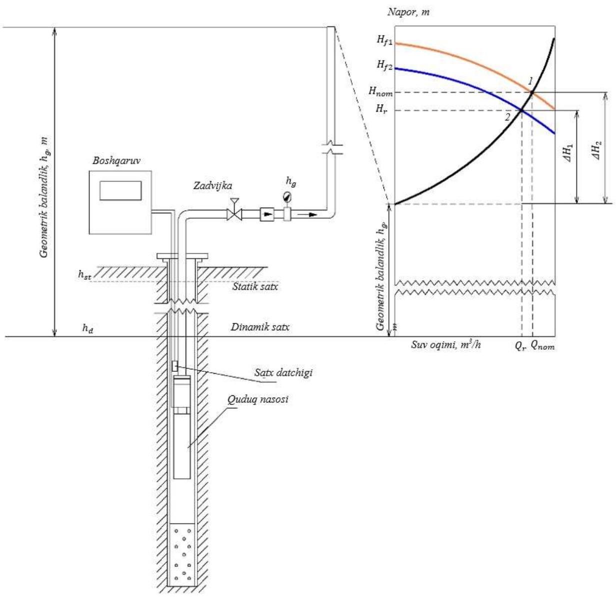

Figure 2. Adjusting the operating mode of the well pump by adjusting the speed of the electric motor

Reducing the annual cost of electricity by reducing the excess pressure of the raised water at a certain volume of water consumption can be determined by the value of the specific power consumption of the pump at a certain indicator:

$$\Delta W = \left(\frac{P(\omega_{nom})}{Q_{nom}} - \frac{P(\omega_r)}{Q_r}\right) Q_{yil} = (w_d(\omega_{nom}) - w_d(\omega_r))Q_{yil}, \qquad (13)$$

where: w_d – specific power of liquid transport, $kVt \cdot soat/m^3$.

Frequency adjustment of the speed of an asynchronous electric motor

Variable speed control technology changes the pump speed and adapts to the load demand. When using Variable Speed Drives (VSD) technology, energy consumption is significantly reduced, allowing the same output to be used with significantly less energy. This, in turn, makes it possible to avoid complex transient processes in electrical networks, ensures the operation of the equipment in the most economical mode [9,10].

The main element of the adjustable frequency drive is the frequency converter, through which the practically constant

network parameters of voltage U_1 and frequency f_1 are converted into variable parameters U_2 and f_2 needed for the control system of the pumping equipment. The speed of the electric motor connected to the output of the converter changes proportionally to the frequency f_2. The "Frequency converter - asynchronous motor" system is characterized by the following mathematical equations:

Three-phase voltage system

$$\begin{cases} U_A = U_{max} \cdot \sin(\omega \cdot t), \\ U_B = U_{max} \cdot \sin\left(\omega \cdot t + \frac{2 \cdot \pi}{3}\right), \\ U_C = U_{max} \cdot \sin\left(\omega \cdot t - \frac{2 \cdot \pi}{3}\right). \end{cases} \tag{14}$$

where:

U_{max} – maximum voltage, V;

ω – angular speed of rotation, rad/sec.

Three-phase rectifier

Average rectified voltage:

$$U_d = 2{,}34 \cdot U_0, \tag{15}$$

where: U_0 – phase voltage of the secondary winding of the transformer.

Average rectified current:

$$I_d = \frac{U_d}{R_n}, \tag{16}$$

where: R_n– nominal load resistance.

The autonomous voltage inverter and its control system are described mathematically as follows [11]:

Phase A output voltage for 6-zone Pulse Width Modulation (IPWM) is described as follows:

$$U_a = \begin{cases} \frac{1}{3}U_n, 0 \le t \le \frac{T}{6} \\ \frac{2}{3}U_n, \frac{T}{6} < t \le \frac{T}{3} \\ \frac{1}{3}U_n, \frac{T}{3} < t \le \frac{T}{2} \\ -\frac{1}{3}U_n, \frac{T}{2} < t \le \frac{2T}{3} \\ -\frac{2}{3}U_n, \frac{2T}{3} < t \le \frac{5T}{6} \\ -\frac{1}{3}U_n, \frac{5T}{6} < t \le T \end{cases}. \tag{17}$$

A three-phase sinusoidal waveform is described as follows:

$$\begin{cases} U_A = q \cdot U_{max} \cdot \sin(\omega \cdot t), \\ U_B = q \cdot U_{max} \cdot \sin\left(\omega \cdot t + \frac{2 \cdot \pi}{3}\right) \\ U_C = q \cdot U_{max} \cdot \sin\left(\omega \cdot t - \frac{2 \cdot \pi}{3}\right). \end{cases} \tag{18}$$

where: q– pulse fill factor.

The output frequency of the analog signal generated by PWM is calculated using the following formula

$$f = \frac{F_{clk}}{N \cdot 512 \cdot Z}, \tag{19}$$

where: F_{clk}– clock frequency of the microcontroller (quartz resonator);

Z– number of pulses;

N– number of inverter switches.

Asynchronous electric motor with a short-circuited rotor

We write the mathematical description of the asynchronous motor in the d-q system in the following form[12,13]:

$$\begin{cases} V_{qs} = R_s \cdot i_{qs} + \frac{d\Psi_{qs}}{dt} + \omega \cdot \varphi_{qs} \\ V_{ds} = R_s \cdot i_{ds} + \frac{d\Psi_{ds}}{dt} + \omega \cdot \varphi_{ds} \\ V'_{qr} = R'_r \cdot i'_{qr} + \frac{d\Psi'_{qr}}{dt} + (\omega - \omega_r) \cdot \varphi'_{dr}, \\ V'_{dr} = R'_r \cdot i'_{dr} + \frac{d\Psi'_{dr}}{dt} + (\omega - \omega_r) \cdot \varphi'_{qr} \\ T_e = 1{,}5 \cdot p \cdot (\Psi_{ds} \cdot i_{qs} - \Psi_{qs} \cdot i_{ds} \end{cases} \quad (20)$$

where: $\Psi_{qs} = L_s \cdot i_{qs} + L_m \cdot i'_{qr}$– the projection of the stator current connection on the q axis;

$\Psi_{ds} = L_s \cdot i_{ds} + L_m \cdot i'_{dr}$– the projection of the stator current connection on the d axis;

$\Psi'_{qr} = L'_r \cdot i'_{qr} + L_m \cdot i_{qs}$– the projection of the rotor current connection on the q axis;

$\Psi'_{dr} = L'_r \cdot i'_{dr} + L_m \cdot i_{qs}$– projection of the reduced rotor current connection along the d axis;

$L_s = L_{1s} + L_m$– stator inductance;

$L'_r \cdot L'_{1r} + L_m$– given rotor inductance.

Electric motor torque is determined by the Kloss formula:

$$M_m = \frac{M_k \cdot (2+q)}{\frac{s_k}{s} + \frac{s}{s_k} + q}, \text{ N·m}, \quad (21)$$

where: M_k– critical moment, N·m;

s– slip;

s_k– critical slip.

Critical slippage:

$$s_k = \frac{r_2}{\sqrt{r_1^2 + x_k^2}}. \quad (22)$$

where: r_1– active resistance of the stator, Om;

r_2– active resistance of the rotor, Om;

x_k– inductive resistance of the stator.

Critical moment:

$$M_k = \frac{3 \cdot U_f^2}{2 \cdot \omega \cdot (\sqrt{r_2^2 + x_k^2} + r_2)}, N \cdot m \quad (23)$$

where: U_f– phase voltage, V;

ω– rotational angular frequency of the electric motor rotor, rad/s.

$$q = \frac{r_1}{\sqrt{r_1^2 + x_k^2}}. \quad (24)$$

Electric motor current:

$$I = \sqrt{\frac{U^2 \cdot 1{,}2}{(r_1 + \frac{r_2}{s})^2 + x_k}}, \text{ A}. \quad (25)$$

The parameters of the T-shaped equivalent circuit are calculated according to the following formulas:

Angular velocity of magnetic field rotation

$$\omega_0 = \frac{2 \cdot \pi \cdot f}{p}, rad/s \quad (26)$$

where: f_1– frequency of the electrical network, Hz;

p– number of pairs of poles.

The nominal angular velocity of the rotor is determined based on the slip expression

$$s_{nom} = \frac{\omega_0 - \omega_{nom}}{\omega_0}, \quad (27)$$

where: ω_{nom}– nominal angular frequency of the electric motor rotor,

$$\omega_{nom} = \omega_0 \cdot (1 - S_{nom}), rad/s \quad (28)$$

Rated motor torque:

$$M_{nom} = \frac{P_{nom}}{\omega_{nom}}, Nm. \quad (29)$$

Nominal phase current of the motor:

$$I_{f.nom} = \frac{P_1}{3 \cdot U_{nom.F} \cdot \cos\varphi_{nom}}, A, \quad (30)$$

where: $U_{f.nom}$– nominal phase voltage, V;
$\cos\varphi_{nom}$– nominal power factor.

Motor power consumption:

$$P_1 = \frac{P_{nom}}{\eta_{nom}}, \quad (31)$$

where: P_{nom}– nominal active power, W;
η_{nom}– nominal efficiency of the electric motor.

The nominal resistance of an electric motor (Om), which must be multiplied by the active and inductive resistances in relative units, to obtain the motor parameters in absolute units:

$$Z_{nom} = \frac{U_{f.nom}}{I_{f.nom}}, \quad (32)$$

where: $I_{f.nom}$– phase nominal current, A.

To recalculate the parameters of the T-shaped equivalent circuit of the motor from relative units to absolute units, we use the following expressions:

active resistance of the stator winding, Om:

$$R_s = R_s^* \cdot Z_{nom}, \quad (33)$$

where: R_s^*– the active resistance of the stator winding,
- inductive resistance of the stator winding, Om:

$$X_s = X_s^* \cdot Z_{nom}, \quad (34)$$

where: X_s^*– active resistance of the stator winding,
- decrease in the active resistance of the rotor coil, Om

$$R_r' = R_r'^* \cdot Z_{nom}, \quad (35)$$

where: $R_r'^*$– active resistance of the rotor winding,
- reduction of the leakage inductance of the rotor coil, Om

$$X_r' = X_r'^* \cdot Z_{nom}, \quad (36)$$

where: $X_r'^*$– dispersion inductive resistance of the rotor coil, Om
bu yerda: $X_r'^*$- rotor chulg‘amining tarqalish induktiv qarshiligi, Om
- inductive resistance of the magnetization circuit, Om

$$X_\mu = X_\mu^* \cdot Z_{nom}, \quad (37)$$

where: X_μ^*– inductive resistance of the magnetization circuit, Om
- specific inductance of the stator

$$L_{\sigma s} = \frac{X_s}{\omega_0}, Gn \quad (38)$$

- specific inductance of the rotor

$$L_{\sigma r} = \frac{X_r'}{\omega_0}, Gn \quad (39)$$

- mutual inductance

$$L_m = \frac{X_\mu}{\omega_0}, Gn \quad (40)$$

- stator coil inductance

$$L_1 = L_m + L_{\sigma s}, Gn \quad (41)$$

- rotor coil inductance

$$L_2 = L_m + L_{\sigma r}, Gn \quad (42)$$

According to the U and f matrix of the linear control law used to start the electric motor, U is determined for the calculated value of f and substituted into the formula to calculate the current and torque of the electric motor. Then, in order to find the current minimum point at which the pump unit supplies water to the water supply system with a certain pressure, the system automatically reduces the voltage by one step without changing the frequency and calculates the motor current. As the voltage decreases, the system decreases by another step until the current increases. After that, the system returns to the previous voltage value at a certain frequency and continues to work, realizing the required pressure in the water supply system.

Since solving the equations of the mathematical model of frequency converter with short-circuited rotor induction motor and centrifugal pump is an analytically demanding task, a computer model was developed to test the formulated hypothesis.

Results. Based on equations (1) - (42) in the MatLab/Simulink program, the simulation model of the "Autonomous voltage inverter - asynchronous electric motor with a short-circuited rotor - centrifugal pump" system was developed.

This model includes the frequency converter's PWM pulse shaper output (voltage) and f (frequency) as control variables. In this model, the data of the stator current is transferred to the workflow and statistically processed, then the maximum value of the stator current is found, and then the input parameters are changed. As the stator current increases, the duty cycle of the pulses changes so that the current is minimal. As a result, we can choose energy-saving modes for any pump and study the laws of frequency converter control.

The data of the simulated machine ПЭДВ 45-219 type short-circuited rotor asynchronous electric motor are presented in Table 1.

Table 1.

The main parameters of the electric motor

Name	Symbol	Quantity	Unit
Synchronous speed	n_{nom}	2919	rpm
Rated power	P_{nom}	45	kW
Number of poles	p	2	-
Nominal efficiency	η_{nom}	0,84	%
Rated power factor	$\cos\varphi_{nom}$	0,83	%
Nominal slip	S_{nom}	0,027	-
Nominal frequency	f_1	50	Hz
Nominal phase voltage	$U_{nom.F}$	220	V
Rotor moment of inertia	$J_{m.r.}$	0,1	$kg \cdot m^2$
Active resistance of the stator winding	R_s	0,074	Om
Inductive resistance of the stator winding	X_s	0,255	Om
Active resistance of the rotor coil	$R_r^{'}$	0,072	Om
Inductive resistance of the rotor coil	$X_r^{'}$	0,342	Om

Inductive resistance of the magnetic core	X_μ	5,770	Om

Angular velocity of magnetic field rotation:

$$\omega_0 = \frac{2 \cdot \pi \cdot f}{p} = \frac{2 \cdot 3{,}14 \cdot 50}{1} = 314\, rad/sek$$

The nominal angular speed of the rotor is determined based on the slip expression:

$$S_{nom} = \frac{\omega_0 - \omega_{nom}}{\omega_0},$$

where: $\omega_{nom} = \omega_0 \cdot (1 - S_{nom}) = 314 \cdot (1 - 0{,}027) = 305{,}522\, rad/sek$

Motor rated torque:

$$M_{nom} = \frac{P_{nom}}{\omega_{nom}} = \frac{45000}{305{,}522} = 147{,}289\, Nm.$$

Motor power consumption:

$$P_1 = \frac{P_{nom}}{\eta_{nom}} = \frac{45000}{0{,}84} = 53{,}571\, kW$$

$$I_{nom.F} = \frac{P_1}{3 \cdot U_{nom.F} \cdot \cos\varphi_{nom}} = \frac{53571}{3 \cdot 220 \cdot 0{,}83} = 97{,}793\, A$$

The nominal resistance of an electric motor (Om), which must be multiplied by the active and inductive resistances in relative units, to obtain the motor parameters in absolute units:

$$Z_{nom} = \frac{U_{nom.F}}{I_{nom.F}} = \frac{220}{97{,}793} = 2{,}249\, Om$$

Let's recalculate the parameters of the T - figurative equivalent circuit of the motor from relative units to absolute units.

Active resistance of the stator winding:

$$R_s = 0{,}074 \cdot 2{,}249 = 0{,}166\, Om$$

The active resistance of the rotor winding decreases according to (35):

$$R_r^{'} = 0{,}072 \cdot 2{,}249 = 0{,}162\, Om$$

The internal inductance of the stator according to (38):

$$L_{\sigma s} = \frac{X_s}{2 \cdot \pi \cdot f_1} = \frac{0{,}051 \cdot 67{,}47}{2 \cdot 3{,}14 \cdot 50} = 0{,}011\, Gn$$

The mutual inductance of the rotor according to (39):

$$L_{\sigma r} = \frac{X_r^{'}}{2 \cdot \pi \cdot f_1} = \frac{0{,}049 \cdot 67{,}47}{2 \cdot 3{,}14 \cdot 50} = 0{,}017\, Gn$$

According to mutual inductance (40):

$$L_m = \frac{X_\mu}{2 \cdot \pi \cdot f_1} = \frac{2{,}5 \cdot 67{,}47}{2 \cdot 3{,}14 \cdot 50} = 0{,}537\, Gn$$

Stator winding inductance according to (41):

$$L_1 = L_m + L_{\sigma s} = 0{,}537 + 0{,}011 = 0{,}548\, Gn$$

Rotor winding inductance according to (42):

$$L_2 = L_m + L_{\sigma s} = 0{,}537 + 0{,}017 = 0{,}554\, Gn$$

Discussion. In order to reduce the stator energy consumption by adjusting the supply voltage during speed adjustment, a computer model consisting of a pulse-forming, three-phase voltage inverter connected to a DC network was built in the MatLab/Simulink R2021a program. The computer model before speed adjustment is shown in Figure 5.

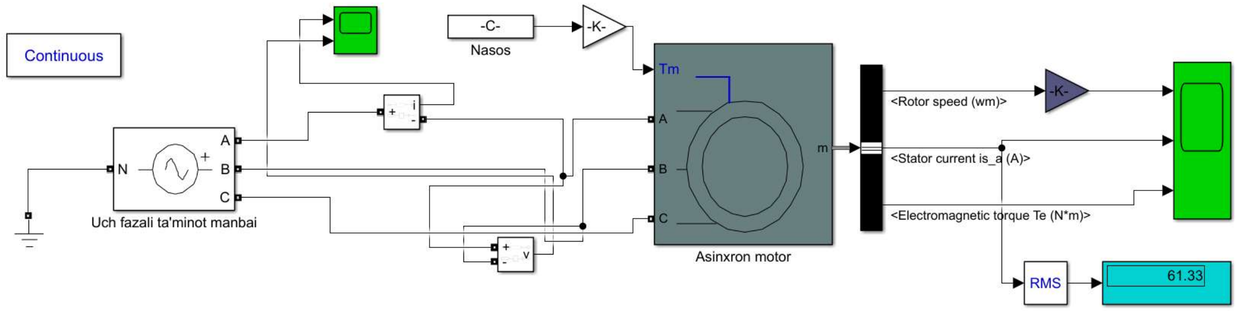

Figure 5. The system "Asynchronous motor-pump" without adjustable speed is a computer model in MatLab/Simulink software

Adjusting the voltage and frequency of the supply source, an asynchronous motor with a centrifugal pump located in the resistance torque. The simulation time was chosen to be 1.2 s, which is enough for the electric motor to transition from start-up mode to operation mode.

As a result of the simulation, the dependences of the rotation frequency, electromagnetic torque and phase current a (Fig. 6) were obtained at the phase voltage U=220 V and the frequency of the supply source f=50Hz. Figure 6 shows the time dependence graph of rotor speed, stator α-phase current and electromagnetic torque before adjusting the speed of the motor.

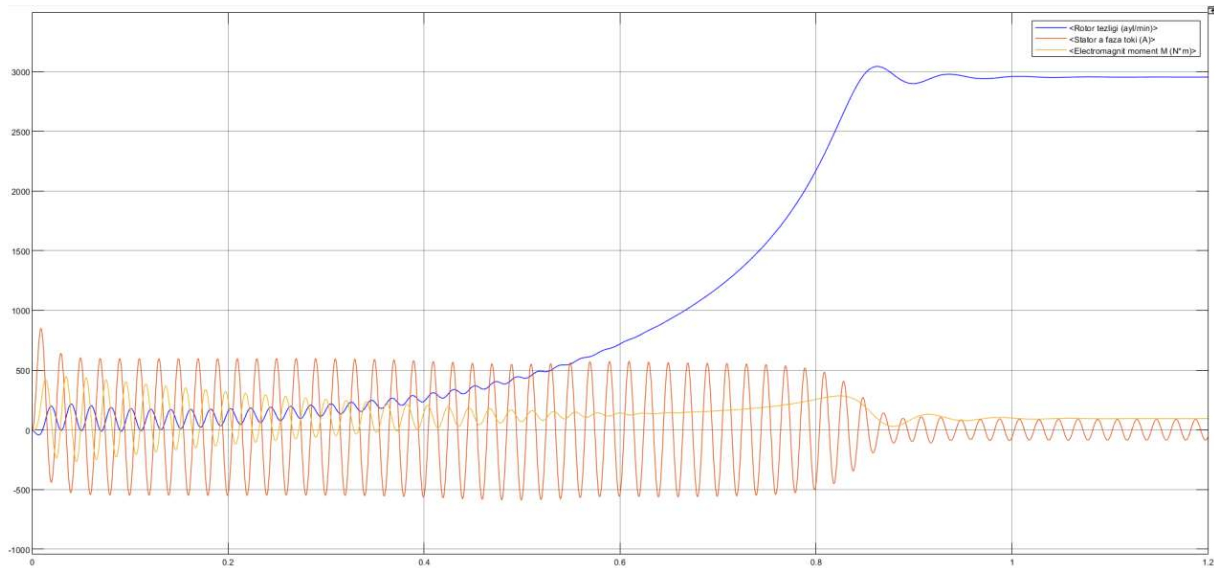

Figure 6. Time dependence graph of rotor speed, stator α-phase current and electromagnetic torque before adjusting the speed of the motor

Analysis of Figure 6 shows that the initialization process takes about 1 s. The maximum value of the starting current reaches 848,702 A.

The maximum value of stator a phase current is 848.721 A, and the minimum value is -589.902 A (Fig. 8).

Similarly, a model is obtained for the case where the speed is frequency adjusted. The computer model in the MatLab system after the frequency adjustment of the asynchronous motor speed is shown in Fig. 7.

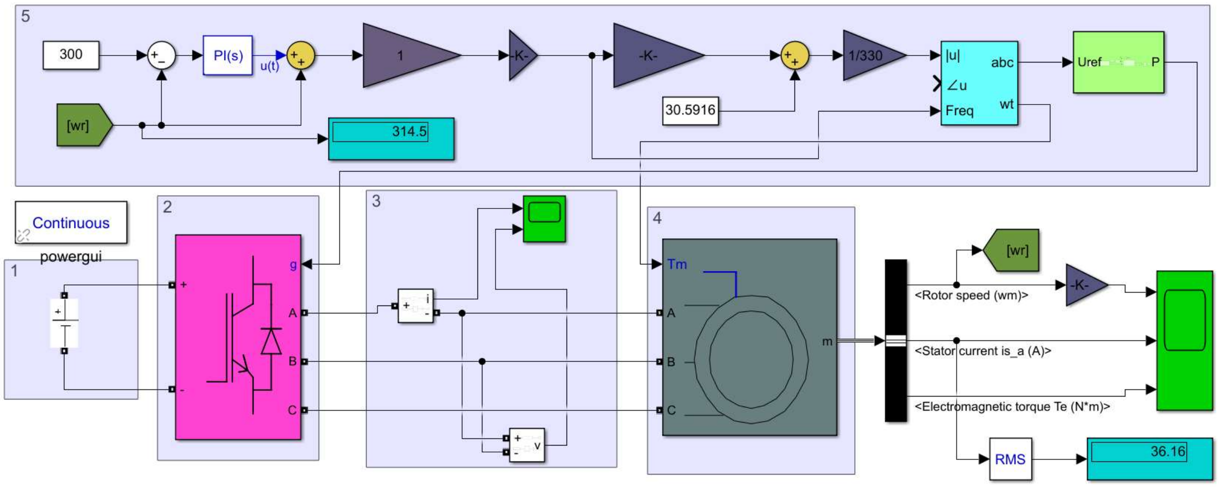

Figure 7. Computer model of frequency adjustment of induction motor speed in MatLab system

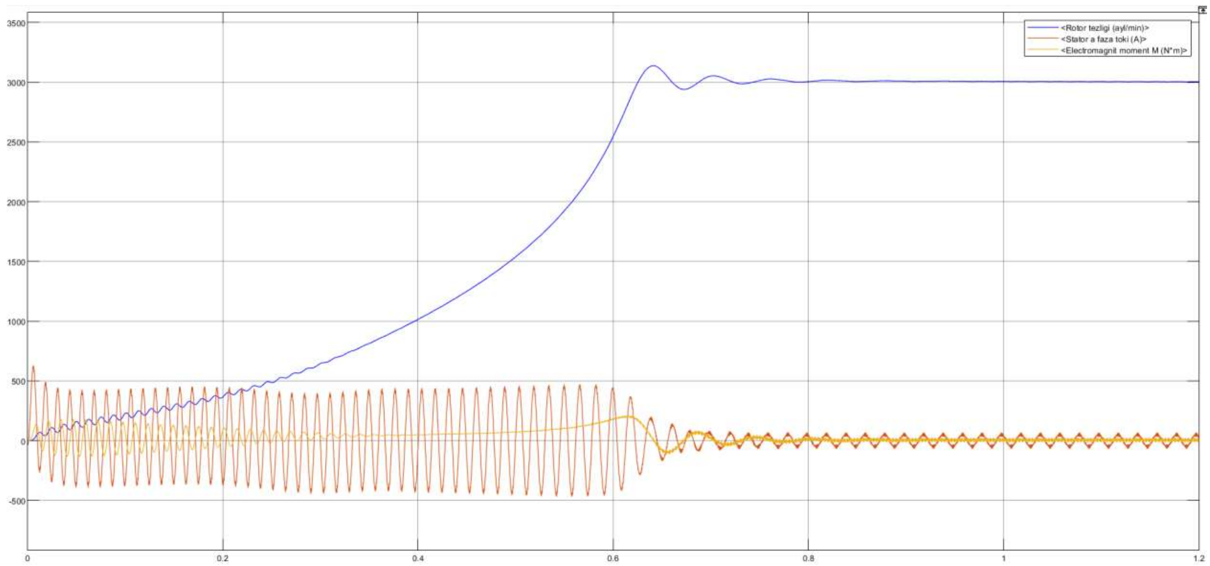

Figure 8. A plot of stator A phase current versus time after speed adjustment

After regulating the voltage at a frequency of 50 Hz, the maximum value of the phase a current of the stator at the start of the electric motor is 631.002 A, and the minimum value is -469.702 A (Fig. 8).

Conclusion. This computer model confirmed the hypothesis that it is possible to reduce the energy consumption of the well pumping system by adjusting the rotation frequency of the electric motor rotor by adjusting the supply frequency in scalar systems of frequency converters at the same mains frequency.

An analysis of the problems of energy efficiency improvement of energy consumption of well pump equipment of water supply systems was carried out. An energy efficiency analysis of frequency regulation was carried out according to the relative parameters of aggregates and water supply networks. The calculation scheme and analytical relations for the integrated method of frequency regulation are presented. Analysis of the obtained results is carried out. The new method makes it possible to significantly simplify the process of energy efficiency assessment at the design stage of well pumping equipment for water supply systems.

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UDK 621-314.212

CONTROL OF VIBRATION PARAMETERS ON THE TANK WALL OF OIL POWER TRANSFORMERS IN OPERATION

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Abstract:

Objective. evaluation of dynamic viscosity of transformer oil according to vibration parameters under operational conditions.

Methods. vibration control, thermal image control, analytical analysis, correlation analysis methods were used.

Results. The dynamic viscosity of the transformer oil and the change value of the dynamic viscosity during the current repair interval were determined with the vibration parameter in the frequency range of 1 kHz to 10 kHz.

Conclusion. The experimental results of determining the oil viscosity by controlling the vibration parameters in the operational state of the oil power transformer were presented. According to the vibration parameters, the indicators of reduction of the dynamic viscosity from the nominal value are determined. During the current technical inspection of transformers, it was possible to determine the condition parameters in a short period of time and at low costs.

Keywords: Oil power transformer, drain, technical condition, diagnostics, method, faults,damage, vibrodiagnostics.

Introduction. To evaluate the technical condition of transformers, it is necessary to analyze the parameters of its elements: temperature, pressure, currents, noise level, vibration frequency, vibration speed, vibration acceleration [2]. Early detection of faults and their causes using diagnostic methods of transformers allows to reduce the cost of electrical equipment by 75%, losses caused by lack of power by 63% and save annual costs by 2% [3]. Today, in connection with the growing attention to saving energy and resources at the level of demand, the scientific researches being carried out to ensure the long-term operation of technological devices are aimed at identifying faults that have started in the transformer, extending its service life, and reducing repair costs. is being studied.

Evaluation of the technical condition of oil power transformers is divided into two groups[2]:

1. Assessment of the technical condition in the case of being disconnected from the network;

2. Evaluation of the technical condition in the state connected to the network (operation).

Technical diagnostics of individual elements of the transformer can be carried out without disassembling the transformer, or with partial or complete disassembly. Diagnostics with dissection includes the use of non-destructive and dimensional control methods and tools for the parameters of individual components and parts. To assess the technical condition without disassembling them, diagnostic indicators are used: temperature, pressure, leakage currents, noise level, vibration amplitude, vibration speed, vibration acceleration, etc. [1]. Shows the classification of the main damage of the power transformer.

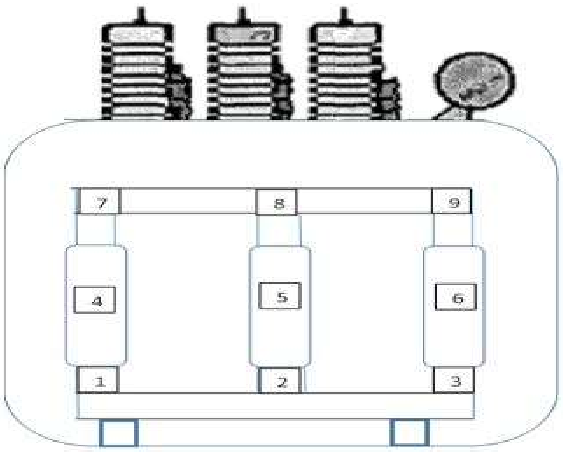
In recent years, the method of vibration diagnostics has been developing in the assessment of the technical condition of oil power transformers. The existing sections of the method of vibration diagnostics allow to assess the technical condition of the mechanical part of oil power transformers. This vibration diagnosis method uses vibration

parameters with a frequency of up to 1 kHz. The results of the high-frequency vibration parameters at 1 KHz do not reflect the results of the mechanical part. Because at a frequency higher than 1 kHz, the effect of mechanical parts in the oscillating motion fades in the oil [3]. In order to increase the accuracy of assessing the technical condition of oil power transformers and to better study the factors that have a negative effect on the operational condition, it is desirable to control them at frequencies of 1 kHz and higher. Research shows that high-frequency vibration parameter values at 1 kHz reflect values arising from small damages. An increase in the particles in the transformer oil indicates that the quality index of the oil is decreasing.

Methods. Diagnostic methods, vibration control, thermal image control, analytical analysis, and correlation analysis methods were used in the research process.

Research results and their discussion. When assessing the technical condition of an oil power transformer, it is appropriate to control its main structural elements and auxiliary elements. In order for the main components of oil-based power transformers to work in long-term operating conditions, it is necessary to have good quality indicators of oil. The use of the vibration control method in determining the technical condition of the oil in operational conditions allows for quick analysis.

In order to carry out vibration diagnostics of an oil transformer under operating conditions, we divide its tank surface into vertical and horizontal parts.



Picture 1. Installation points of sensors for monitoring vibration parameters on the surface of the transformer tank

When carrying out the research results, the vibration results are analyzed according to the frequency. We get the results of the vibration parameter up to 1kHz as values that are resolved in the active part of the transformer. In this case, it is appropriate to accept the values in the lower part. Because the vibration in the mechanical parts, that is, in the ferromagnetic core and coils, spreads to the transformer tank through the base. It is desirable to take into account the value of the vibration parameters at values higher than 1 kHz at the surface of the tank. At high frequency, the vibration parameters of mechanical parts fade and reflect the vibration parameters of small particles. Small particles move along the entire tank along with the oil and create a vibration effect in the transformer tank. The moving

particles in the oil consist mainly of oil droplets and water droplets, and as its value increases, the values of the vibration parameters also increase.

Picture 2. Oil in operation has high frequency oscillations compared to power transformer oil

The impurities in the oil are considered as mechanical impurities. An increase in mechanical impurities means that the quality indicator of transformer oil is deteriorating. Monitoring the technical condition of the transformer elements in accordance with the frequency range, while recording the vibration parameters of oil power transformers and studying the reasons for the formation of these parameter values.

According to the vibration parameters in the frequency range from 1 kHz to 10 kHz, the dynamic viscosity is studied in laboratory conditions by taking samples from the oil of each measuring transformer. The dynamic viscosity of the transformer oil was determined using the "Viscosometer" device.

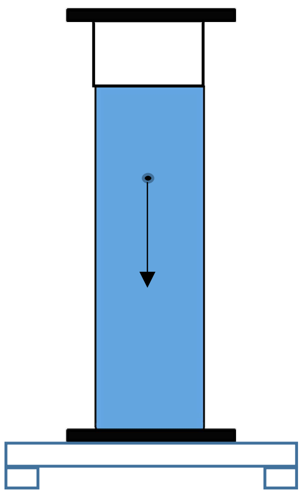


Figure 3. Capillary viscometer

The oil of each transformer whose vibration parameters were controlled was checked for its dynamic viscosity using a viscometer laboratory stand. As a result of these tests, the values of dynamic viscosity were studied according to the change of the temperature of the transformer oil in accordance with the results of the vibration speed of the oil power transformer. Viscosity indicators of liquids change depending on its temperature. But the quality indicators of the liquid accelerate these value changes.

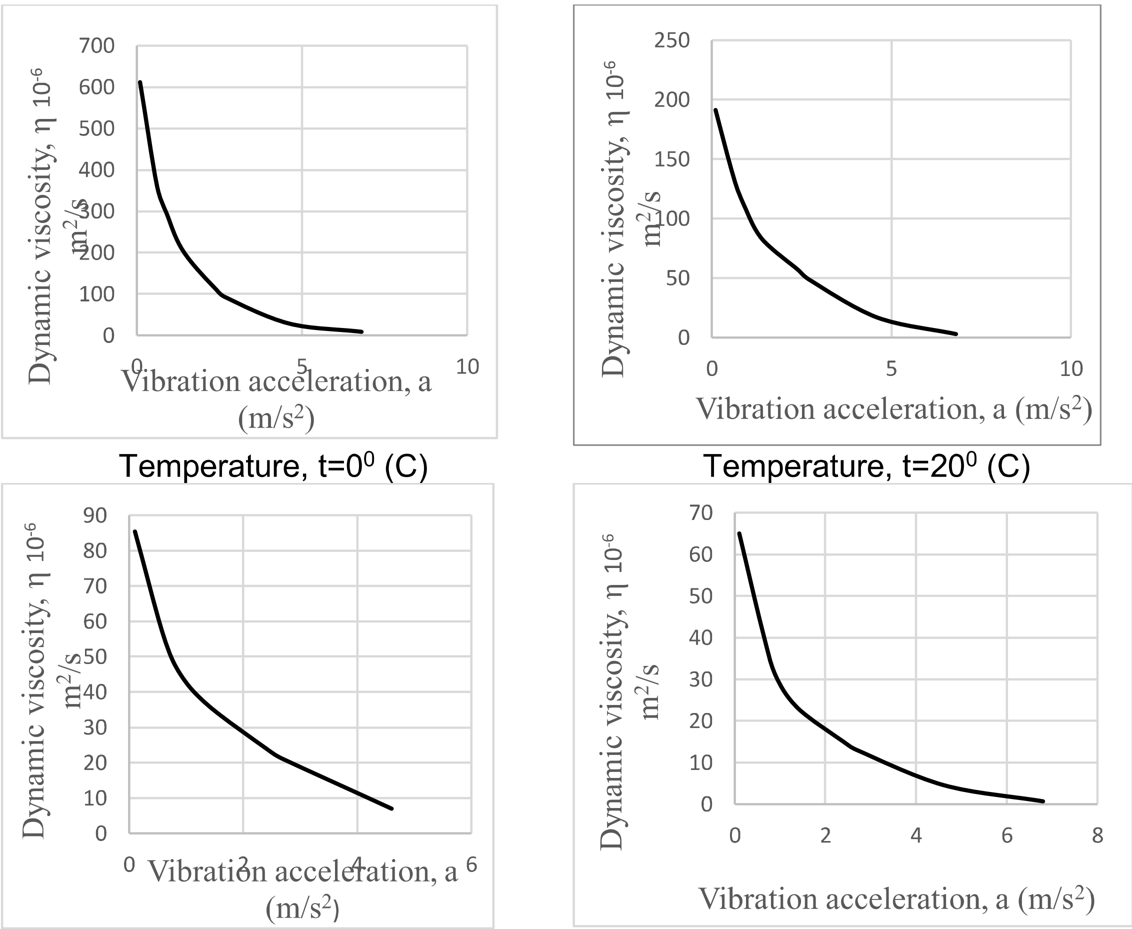
The results of determining the dynamic viscosity of the liquid in Figure 3 can be expressed by the following formula:

$$\eta = \frac{2(\rho_j + \rho_s)gr^2}{9v} \tag{1}$$

Here:

ρ_j – ball density, ρ_s – liquid density, r – the radius of the sphere, v – the ball's falling speed, g – acceleration of a body in free fall.

We can see the process of change of dynamic viscosity according to the vibration acceleration for the same temperature on the viscometer laboratory stand through the following characteristics.



Temperature, t=0⁰ (C) Temperature, t=20⁰ (C)

Temperature, t=40⁰ (C) Temperature, t=50⁰ (C)

Figure 4. Characteristics of the results of the vibration acceleration of the transformer oil depending on the dynamic viscosity at different temperatures

According to the results of the research, table 1 was formed on the expression of the dynamic viscosity of the oil at different temperatures by the vibration parameters affecting the wall of the transformer tank according to the quality indicators.

Table 1

Temperature, t (c)	Vibration acceleration, a (m/s^2)							
	0,1	**0,6**	**0,9**	**1,4**	**2,4**	**2,7**	**4,6**	**6,8**
0	611.4	365.1	302.7	203.4	111,2	91.3	29.1	9.1
10	325.5	235.2	186.4	121.2	82.2	64.3	22.2	7.8
20	191.4	135.2	111,2	83.1	57.6	49.7	17.1	2.97
30	121.3	95,1	74,2	61.6	45.4	42.5	12.3	2.57
40	85.4	67.2	51.3	36.1	28.5	25.3	7.2	2.11
50	65.7	42,1	31.6	27.5	21.8	17.7	3.3	0.65
60	46.2	34.3	26.4	19.6	10.4	8.1	1,34	0.55

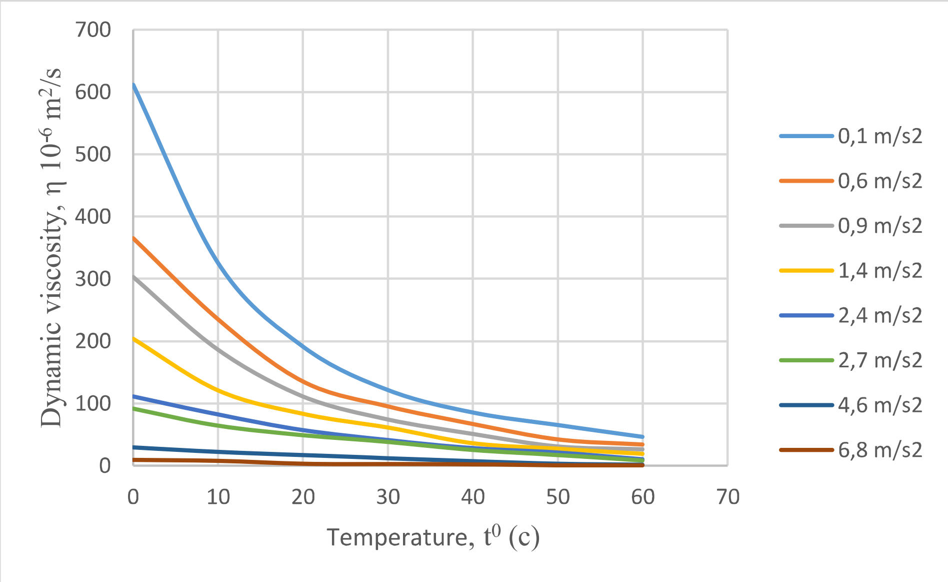


Figure 5. Characteristic of dependence of dynamic viscosity of transformer oil on vibration parametric and temperature

Based on the characteristics in Figure 5, we can clearly see the dynamic viscosity of the transformer oil at different temperatures and the vibration indicators affecting the tank wall.

Monitoring the dynamic viscosity values of oil power transformer oil under operational conditions allows them to accurately plan the maintenance costs and service plan of the maintenance personnel. It is possible to reduce the effect of factors such as load and external temperature changes affecting the operation of oil power transformers.

By comparing the quality indicators of transformer oils with controlled vibration parameters, we can see the excess demand placed on the transformer during scheduled maintenance intervals. As an example, we can consider the graph of changes in the quality indicators of transformer oil during the current maintenance period of transformers, that is, six months of control.

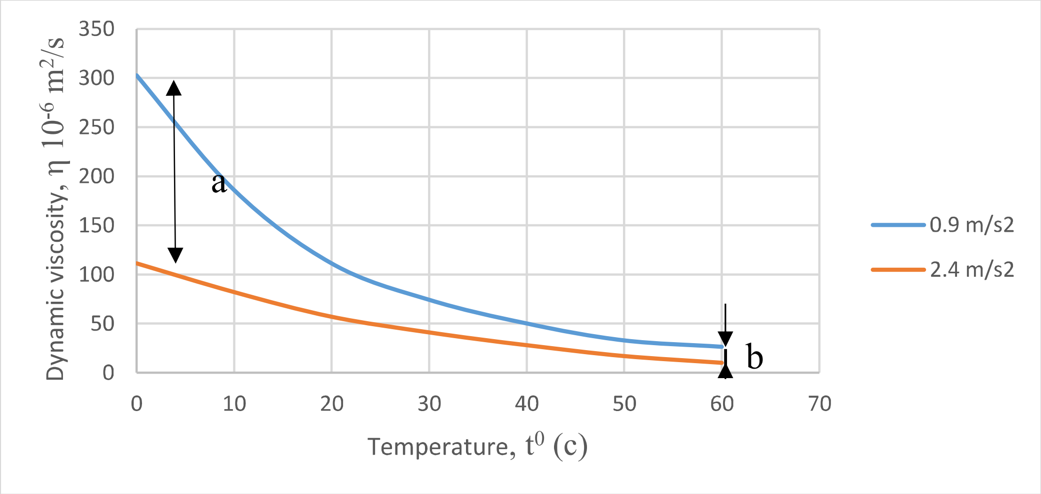


Figure 6. The difference in the change of the dynamic viscosity of the oil during the current maintenance interval

The quality indicator of the oil during the current repair period of the oil power transformer allows to determine whether the value of the change exceeds the demand for it. The b value in Fig. 6 is the Δη value of the quality indicator of the transformer oil in the operational state over time between the first control and the second control.

$$\Delta\eta = \eta_2 - \eta_2 \qquad (2)$$

Here:

η_1 – dynamic viscosity of the oil at the initial time;

η_2 – dynamic viscosity of oil over time.

It is recommended to control the load of the transformer taking into account the temperature of the external environment in accordance with the value of Δη of the oil. The dynamic viscosity of the oil represents the ability to transfer the temperature of the transformer core to the external environment.

Summary. The experimental results of determining the oil viscosity by controlling the vibration parameters in the operational state of the oil power transformer were presented. According to the vibration parameters, the indicators of reduction of the dynamic viscosity from the nominal value are determined. During the current technical inspection of transformers, it was possible to determine the condition parameters in a short period of time and at low costs.

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METHODOLOGY FOR ASSESSING THE LEVEL OF TRAIN SAFETY

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Abstract. The results of the analysis of the existing methods of train safety management show that these methods are not enough to solve the issues of economic traffic safety management. This means that there is a need to develop a methodology to improve the efficiency of traffic safety management. This article presents a newly developed new methodology for assessing the level of safety of train traffic, in which the formula for determining the level of safety of cargo transportation is developed taking into account the

correction factor, taking into account the number of crashes, accidents, defects in operation and other incidents, the standard of the level of safety of vehicles and the severity of individual cases of safety violations.

Keywords: Train safety, wrecks, accidents, accidents at work, the level of safety.

Introduction. Railway transport is considered the basis of modern economy and serves as an object of market relations. Effective organization of its activity is related to the operation and development of all sectors of the economy, their associations and complexes. Despite the fact that they make a great contribution to the economy of our country, until today there are certain violations of train traffic safety in railway transport.

Traffic safety is the protection of the transport system from traffic disturbances that harm passengers, shippers, the external environment and the transport system itself (accidents, collisions, stoppages due to malfunctions, wrong-way traffic, etc.) protection status is understood.

The state of the risk, which is determined depending on the probability of the occurrence of the risk and its possible consequences, is the level of risk. Normative legal documents related to ensuring the safety of cargo and passenger transportation on railways, maintenance, service, repair and use of railway equipment and technical means in motion, and normative documents in the field of technical regulation and the set of criteria that allows to assess the risk of non-fulfillment or incomplete fulfillment of the requirements and then categorize the stations or departments of the enterprise according to the level of risk constitutes the criteria of the level of risk.

According to modern scientific and practical ideas, road safety of any product is one of the most important indicators of its quality.

The goals of ensuring transport safety are the stable and safe operation of the transport complex, the protection of the interests of individuals, society and the state in the field of the transport complex from illegal interference.

of the Law of the Republic of Uzbekistan "On Transport".

Article 5 contains the main principles of transport activities, which are as follows [7]:

- legality;
- security;
- environmental cleanliness;
- being able to use transport services;
- openness and transparency.

The object of research is subjects operating in the field of railway transport, which carry out cargo transportation. The subject of research is the method of evaluating the level of safety of train traffic as an indicator of the quality of transportation service. The purpose of the research is to manage the quality of the transport service and to prevent accidents, accidents and incidents by creating an opportunity to comprehensively objectively assess the level of its safety. The objectives of the study are to assess the quality of the service provided by the railway transport to consignees and consignors and to improve the safety of cargo transportation.

Literature analysis and methods. In the course of research conducted in the world, a number of scientific works on safe and efficient organization of shunting operations at the station, safe and timely delivery of goods and passengers to their destinations by introducing a comprehensive assessment system of the condition of the railway infrastructure have

been performed [1-7], but not enough scientific work has been carried out on the methodology of evaluating the safety level of train traffic, which allows for a comprehensive objective assessment of the quality of transportation service and its safety level.

Taking into account the scale of transport activity of railway transport and, accordingly, the increase in the level of transport safety and the scale of economic consequences arising from its decrease, the search for opportunities to assess the level of train traffic safety is considered one of the most urgent tasks.

Results and their discussion. The procedure for risk assessment is the regular determination of the probability of the occurrence of a risk and the consequences of violations of the legal documents related to the railway transport sector in the event of its occurrence.

Transportation security, along with other indicators (speed of delivery, safety, continuity, etc.) is an important feature of the quality of transportation services provided to customers.

The safety situation is usually characterized by the number of absolute (number of incidents in a time interval) or specific (number of incidents per 1 million t.km.) number of violations.

At the same time, it is very important to assess the level of security, that is, the difference between the actual and normative state of security, because it is necessary to evaluate the results of security management. Various methods have been proposed for this, in particular, the following [8]:

$$K_{ext.risk.} = 1 - \frac{B_{norm\ of\ risk}}{B_{level\ of\ risk} + \phi_{risk.dis.}} \quad (1)$$

here $K_{ext.risk.}$ – is the level of cargo transportation security, expressed in units of shares, $0 \le K_{tash.xavf.} \le 1$;

$B_{norm\ of\ risk}$ – standard of safety level of vehicles (accepted at the level of 0.95-1);

$B_{level\ of\ risk}$ – the actual level of safety of the transportation process, The number of accidents, accidents and other incidents per 1 million t.km.;

$\phi_{risk\ dis}$ – correction coefficient ( ), which takes into account the scale of losses caused by individual cases of security violations that caused serious damage.

In this case, the problem of determining the scientifically based value of the safety standard (values, criteria, etc.) arises. It is necessary to determine which violations are normative (that is, allowed).

If violations of the rule are accepted as completely absent, and the absolute value of the standard of safety level of vehicles is expressed in the form of $B_{norm\ of\ risk} = 0$, regardless of the number of violations, the expression (1) by itself is $K_{ext.risk.}$ – will not solve the problem.

In the case of excluding the influence of the "human factor", the level of safety can be measured by the reliability of the technical system [9]:

$$K_{ext.risk.} = 1 - \prod_{i=1}^{n}(1 - P_i) \quad (2)$$

here n – number of system elements;

P_i – the probability of uninterrupted, i.e., uninterrupted operation of element i – in the system.

However, this value is only a feature that indicates the level of potential safety probability, not its actual level.

If, however, we assume that the standard state of safety is achieved in the complete absence of violations, then the formula for determining the level of safety of cargo transportation can be expressed as follows:

$$K_{ext.risk.} = \frac{N_{w-d.}}{N_0} = \frac{1-N_{disordered.}}{N_0} \quad (3)$$

bu yerda $N_{w-d.}$ – the number of shipments delivered without damage (accidents, accidents and other incidents);

N_0 – the total number of freight shipments in the same period;

$N_{disordered.}$ – the number of cargo shipments delivered in violation of established security standards.

Taking into account that security breaches have different consequences, it is appropriate to include the coefficient (3) that takes into account the severity of security breaches for each $\phi_{risk.dis.} \geq 1$ cases.

The equivalent of correlating the severity of damage, that is, to calculate the coefficient $\phi_{risk.dis.}$, the ratio of the amount of damage may be different in different cases of security breach. After taking into account these circumstances, the formula (3) for determining the level of cargo transportation security looks like this:

$$K_{ext.risk.} = \frac{1-\sum N_{dis.} \cdot \phi_{risk.dis}}{N_0} \quad (4)$$

As a result of the use of this formula, it is possible to objectively assess the quality of the transportation service and its level of safety.

Conclusion. The proposed train is a new method of evaluating the level of traffic safety, which allows for a comprehensive objective assessment of the quality of the transportation service and its level of safety.

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UDC 372.854

USE OF INTEGRATED TECHNOLOGIES IN VOCATIONAL EDUCATION

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Abstract: There is discussed in the article importance of ICT and pedagogical technologies implementation in «Food sekuritu and safety eguipment» teaching in higher education institutions. The article clarifies informational communication and pedagogical technologies, integration, integrated education and these meanings.

Keywords: IT - informational technology, pedagogic technology, communication, integration, integration education, communications, animations.

Introduction. The socio-economic reforms that have been carried out and are increasing in the country have led to fundamental changes in all aspects of society, including the education sector, its development, compared to other social institutions, is aimed at securing the future, which is worthy of every nation, every family, every citizen of Uzbekistan. , aimed at developing the formation of a safe life. It is important to develop this in professional educational institutions. In this regard, the demands placed on the quality of the professional activity of professors and teachers, including teachers of "Labor protection and safety technology" are increasing.

The analysis of the development dynamics of accidents, injuries and injuries caused by technical, sanitary-hygienic, psychophysiological, organizational reasons shows that in the coming years, the urgency of combating the causes and consequences of accidents, occupational diseases, and injuries occurring at workplaces will increase.

The relevance of the problem of improving the use of integrated technologies in imparting knowledge on "Labor protection" to the students of professional education is related to the need to solve the problems between the need to protect the health and safety of workers in society and the actual situation of workers today. Until now, the methodology of organizing practical and laboratory trainings related to labor protection for teaching the science of "Labor protection" in professional educational institutions with the help of

information communication and pedagogical technologies has not been developed, but scientific research works on creating new software are being carried out.

According to the results of the pedagogical experiment, students can master 80% of the practical training they have conducted, as a result of the analysis and synthesis of other information they have written about them.

Decree No. 5812 of the President of the Republic of Uzbekistan dated 06.09.2019 "On additional measures to further improve the system of professional education", Decree of the Cabinet of Ministers of the Republic of Uzbekistan dated 07.08.2020 "Regulating the system of continuous primary, secondary and secondary special professional education in the Republic of Uzbekistan -Decision No. 466 "On approval of legal documents", Decision No. 4623 of the President of the Republic of Uzbekistan dated 27.02.2020 "On measures to further develop the field of pedagogical education", Decision No. 4623 of the President of the Republic of Uzbekistan dated 06.11.2020 "On further improvement of the educational system" Decision No. 4884 of the President of the Republic of Uzbekistan dated 31.12.2020 No. 4939 of the Cabinet of Ministers of the Republic of Uzbekistan dated 15.05. The use of integrated technologies in vocational education effectively serves the implementation of the tasks defined in the Resolution No. 287 of 2020 "On measures to organize the activities of the national system of development of professional qualifications, knowledge and skills in the Republic of Uzbekistan" and other regulatory legal documents on the subject.

With the help of information technology, when there is an opportunity to demonstrate the mechanisms "live", creating an animation related to the topic with the help of a computer and introducing it in the lesson can have a great effect on increasing the effectiveness of the lesson. Therefore, it is not possible to explain the subjects of the "Labor protection and safety techniques" training program for professional learners in traditional ways and increase the level of mastery of the subjects. In order to solve this problem, it is necessary to create a method of covering selected subject materials based on information and pedagogical technologies. In the integration of information communication and pedagogical technologies, the improvement of the teaching methodology of the subject "Labor protection and safety techniques" consists in the development of integrated technologies and the basis of their use, content and methodical system.

Level of study of the problem. In the world, many scientists have conducted scientific research on improving the teaching of labor protection on the basis of nanotechnology, information and pedagogical technologies. Examples of them include L.A. Savchenko, Michael Seery, Stephanie O'Brien, K.B. Oralbaeva, L.A. Chernisheva and others. Scientific research works based on information and pedagogical technologies in improving the quality of education in Russia E. O. Emelyanova, E. Yu. Zashivalova, A. A. Syromatnikov, V. N. Likhachev, A. A. Podgornova, A. S. Artemeva, O. E. Gobunova, N. S. Mikhaylova, A.P. Conducted by Ershov. M.M.Aripov, A.A.Abdugadirov, A.Kh.Abdullaev, N.V.Apatova, U.Sh.Begimkulov, T.Boboev, M.Lutfullaev, J.O.Tolipova on the implementation of information and pedagogical technologies in the educational process in Uzbekistan , D. Yusupova, it can be noted that E. U. Eshchanov, F. A. Alimova, L. T. Zaylobov, N. A. Anvarova carried out research in teaching the science of labor protection by introducing information and pedagogical technologies.

The scientific novelty of the research is as follows:

- use of pedagogical technologies in teaching "Labor protection and safety techniques" in professional educational institutions and explaining the meaning of these technologies to students;

- to explain the methods of teaching "Labor protection and safety techniques" using information technologies;

- to explain the methodology of teaching labor protection and safety techniques with the help of integration of information-communication and pedagogical technologies;

- explaining the meaning of integration and integrated technologies to learners.

The object of the study was the educational process of "Labor protection" in professional educational institutions, where the science of labor protection is deepened.

The subject of research. It consists of methods and tools to improve the content and form of the methodology of teaching labor protection in the integration of information and communication and pedagogical technologies in professional educational institutions where the science of labor protection and safety technology is taught.

Research methods. Studying and summarizing the advanced work experiences of teachers of professional educational institutions; modeling, sociometric (questionnaire, test), survey; direct and indirect pedagogical observation; to compare pedagogical experiment-test; methods of mathematical statistics. In the study, the issues of integrated technologies and their use in the educational system, their essence and development of the methodical system are described, observation, scientific-methodical analysis and generalization methods are used.

A number of practical research works are being carried out in our country in order to develop the education system and increase its effectiveness. The main content of such research works is as follows:

- bring the content of education to a new content based on foreign experiences and create new generation educational literature based on them;

- improvement of teaching process of educational subjects using computer technologies;

- introduction of new generation information and communication technologies into the educational process;

- introduction of modern pedagogical, innovative and integrative technologies into the educational process, etc.

Methods and tools of education are of particular importance in providing quality and guaranteed education in the educational process. It is important to use integrated, that is, integrated technologies in the organization of the educational process at the level of modern requirements.

The word integration corresponds to the Latin word "integratio" and in Uzbek language it means to restore, start again, fill. The relationship between individual parts and elements is a concept that represents their integration.

The word integration is also used to describe the process of convergence and interconnection of disciplines. The concept of integration is one of the important scientific terms, it is a methodological tool for generalization and drawing conclusions. In science and technology, with the help of this methodological tool, general models and algorithms of harmony between the contents of a process or events are created.

The essence of integration is also of particular importance in solving the problems of ensuring harmony in the content of education provided in the continuous education system. The main concepts of subjects taught through integration are summarized. The concept of integration is also used to establish a

relationship between information about a research object and methodology.

Integrated technology refers to technologies resulting from combining, summarizing, and establishing relationships between two or more technologies.

The use of integrated technology in the educational process means the state of conducting activities by combining, summarizing and establishing connections between pedagogical and information communication technologies.

The level of students' mastery of educational subjects is one of the main factors determining the quality and effectiveness of the lesson. In improving the quality of education, it is important to properly plan the lesson and define the goal correctly and clearly. When setting the goal, it is important to determine the time it takes to achieve the result, the needs and capabilities of the learner, the methods directed at the learner to try to achieve the goal, and the types of control that determine the result. In order to achieve this goal, it is necessary to introduce modern pedagogical technologies into the educational process.

Pedagogical technology is a product of the integration of pedagogical and technological approaches used in the educational process. Different pedagogues approached the concept of pedagogical technology in different ways and defined it differently.

Pedagogical technology is a set of educational methods, methods and educational tools, it is a set of organizational and methodological tools of the pedagogical process. Pedagogical technology is a systematic method of creation, application and determination of the entire process of teaching and knowledge acquisition, taking into account technical resources and human interaction, which sets itself the task of optimizing educational forms. Pedagogical technology consists of the process of transferring and acquiring information in a form and method convenient for learning. Pedagogical technology is a process that guarantees the education of the learner to study independently, acquire knowledge, and think.

In the process of pedagogical technology, under the guidance of the teacher, the learner independently acquires knowledge, learns, assimilates. Therefore, pedagogical technology consists of the activity of influencing a person according to a predetermined goal.

Information technology is the total methods, devices, methods and processes used to collect, store, search, process and disseminate information. Information technologies - ways, methods and methods of using a computer in the process of collecting, processing, storing, transmitting and using data. Information technology is a process related to the use of modern computers in order to reduce the laboriousness of the processes that use this information for processing information and increase their reliability and speed. Therefore, information technology means a set of methods and tools for collecting, storing, transmitting, changing, and processing information.

Modern information technology is a technology that can enable to raise education to a new level of quality by organizing the educational process related to the formation of knowledge, skills and abilities for young people studying in educational institutions based on new approaches.

Communication is derived from the English word "communication" and is used in Uzbek in the sense of communication, message, means of communication, means of information, connection, communication, connection, methods and means of information transmission. A communication system is a system that performs auxiliary tasks related to information transmission among other systems. Communication technologies are

technologies that perform the function of routing (characterizing) and switching connections for the transmission of information between computers in a network. Information and communication technologies of the educational system perform the following basic functions and requirements:

●recording of students and their activities of using the information environment;

● taking into account the support of the activities of educators and learners through counseling;

●recommendation to learners for independent learning of the necessary educational materials;

●organization of control of knowledge, skills and abilities acquired by students during the educational process with the help of tests, as well as oral and written control;

● to enable remote use of the information resources of the educational institution to use the educational materials, additional literature and other tools recommended for students in the information base;

●organizing advice and other assistance of the employees of the educational institution remotely in performing virtual laboratory exercises and practical assignments, etc. The main content of educational subjects in the educational process organized on the basis of integrated technologies will consist of the following methodological materials1 : 1 Borovskikh. T.A. Individualization of education, chemistry, and sovremennyx obrazovatelnyx technology. - M., MPGU. Virtual Gallery, 2011. - p. 217.

● electronic teaching-methodical complexes;

● a set of test programs and questions for self-control;

● virtual laboratory works and their description;

● independent work and control work;

● computer programs, electronic references, electronic applications;

● additional software.

As a result of the use of integrated technologies, training sessions are organized remotely using the capabilities of network technologies. This is the basis of distance learning.

The main task of network technologies in distance education is to ensure communication between the teacher and the student during the educational process. The educational process organized without constant communication between the teacher and students will not give the intended effect. In the daytime form of the educational system, communication between the teacher and the student is carried out at the same time, in the same place, in the classroom. In distance education, this process is carried out through computer network technologies based on telecommunication tools.

The integrated state of the three technologies discussed above can be considered as the most optimal technology for teaching and learning. Creating an information-educational environment for students using the possibilities of pedagogical and information technologies, integrated technologies of delivery processes to students on the basis of communication technology tools is the main task of the main technologies.

The education system of our country is currently undergoing major changes, as this trend of education development is common to all developing countries. At such a stage, the national economy needs free-thinking, entrepreneurial, mature specialists who are knowledgeable in their chosen profession, who can independently find solutions to problems. To train such specialists, it is required to apply the acquired theoretical knowledge in practice and to have the ability to independently master new scientific problems in science. Because the large-scale reforms carried

out in the field of education today, the adopted state decisions regarding the improvement of the content of education require connecting education with life, increasing the effectiveness of teaching, raising a well-rounded generation for the rapidly developing society.

The use of Internet information in the subject of "Labor Protection and Safety Techniques" teaches students to express their opinions in a group, to think and work independently, to be resourceful, and to be present. It increases their interest in the science of "Labor protection and safety technology", encourages students to be active. Therefore, it is aimed to analyze and illuminate the issue of introducing innovative technologies into the teaching process of "Labor Protection and Safety Techniques" and improving it from all aspects.

The changes taking place in the field of education, the influx of a large flow of information, the emergence of the need for rapid acquisition of knowledge require the introduction of integration in the fields of education. Also, the use of modern information technologies in teaching is gaining special relevance.

When we studied the current situation regarding the introduction of the use of information and communication and Internet information in the lessons of "Labor protection and safety techniques", most teachers noted that the lesson processes were interesting and effective. There are not enough scientifically based templates and guidelines for the introduction of information technologies into the educational process in continuing education.

The use of information and communication technologies (ICT) in the classroom opens up new perspectives and effective teaching opportunities for teaching "Labor protection and safety techniques". At the same time, the development of independent reading skills leads to certain literacy in working with information technologies, which is a necessary condition for the intellectual development of students. Using information and communication technologies in the classes of "Labor Protection and Safety Techniques", homework can be assigned remotely by the teacher and the tasks completed by students can be checked by using Internet resources. ICT is the most convenient way to control learning materials.

In short, integrated technologies are of particular importance in organizing the educational process, summarizing and supplementing the educational content at the level of modern demand, and help to guarantee the achievement of the intended goal.

The results of the research and the conducted experiments were the basis for drawing the following conclusions:

1. The skills and competencies formed by students during the teaching of "Labor Protection and Safety Techniques" in the direction of professional education general vocational sciences were determined, and it was explained that it is necessary to use information and pedagogical technology tools depending on the knowledge in the teaching process.

2. The didactic functions of the information technology tools used in teaching the science of "Labor protection and safety techniques" were determined and the determination of the ways of their implementation created a basis for increasing the educational efficiency, and the scientific-methodical aspects of the educational process were determined.

3. The scientific-methodical basis of using information communication and pedagogical technology integration in theoretical and practical lessons in the teaching of "Labor Protection and Safety Techniques" was developed and applied to the educational process.

Based on the above considerations, the following recommendations were developed in connection with the research

work:

1. The tools of information and pedagogical technologies are considered a necessary component of the educational process organized in the subject of "Labor protection and safety techniques". Therefore, the use of information and pedagogical technologies in the teaching of all subjects included in the curriculum in accordance with the educational content guarantees the effectiveness of education.

2. It is necessary to include information and pedagogical technologies in the educational process organized in the training and retraining courses of teachers of labor protection and safety techniques, who are engaged in pedagogical activities in the field of professional education.

3. Using animations, models, slides, and computer-aided tests of knowledge, skills, and abilities of students in the field of "Occupational Protection and Safety Techniques" that are products of information technology created during the research, successful teaching of "Occupational Protection and Safety Techniques" in general secondary schools recommended to use.

5.

4. Since the use of information technology products in the teaching of labor protection and safety techniques requires specific training from the labor protection teacher, the results of the research are used in the system of pedagogical personnel training, as well as retraining and qualification of teachers of labor protection and safety techniques in secondary special, vocational, professional education. It is recommended to use it in the refresher course.

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UDC 621. 22-226

TECHNOLOGY FOR CREATING ENERGY PARAMETERS AND THE GEOMETRIC SHAPE OF A JET TURBINE WITH A NOZZLE

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Abstract:

Objective. This article reflects the importance of low-pressure micro hydropower plants today, information about the problems, causes and ways to solve them. The problems of micro hydroelectric power stations continue to be studied all over the world. Opinions and recommendations are important because the scientific works and literature of about 20 world scientists and researchers were studied as sources, as well as scientific information.

Methods. About 20 literatures have been studied, which consider the design of microhydroelectric power plants operating in low-pressure water sources, the factors causing power losses in them. Based on the research results, the energy relationships between their constructive and geometric dimensions are analyzed. Factors affecting efficiency were calculated.

Results. Based on the analysis of the literature, calculations were made for the impeller of the turbine of a microhydroelectric power station. The number of nozzles in the turbine, the angle of inclination, the number of guide vanes, the central angle between the guide vanes, the water flow rate, the diameter of the guide device, the feed cylinder, the taper angle at which the water flow rate is the least energy in flat compression. The calculations were revised by introducing boundary conditions for several options. It has been established that when the radius R2 of the guiding cylinder is equal to the radius of the supply cylinder, the energy losses for energy expansion (compression) are minimal. It was found that the diameter of the impeller of a hydraulic turbine can be changed to fit the size of the nozzle, however, an increase in the diameter leads to an increase in the moment of inertia about its center and a sharp decrease in the rotational speed . The water intakes of the hydraulic turbine feed cylinder and the nozzle are made round, and the ratio between their surfaces is analyzed.

Conclusions. The diameter of the water supply cylinder of the hydroturbine has been increased in places where it is planned to work in sources with high water consumption and low pressure. This situation leads to an increase in the diameter of the impeller. Exceeding the critical value of the impeller diameter leads to an increase in the moment of inertia and a decrease in the speed of the impeller. This, in turn, leads to excessive energy losses due to the use of additional pulleys or gearboxes.

Keywords: Nozzle, jet turbine, microhydro, low pressure, Segner water wheel, gearboxes, Darcy coefficient.

Introduction. Under the influence of climate change in 2021, the volume of electricity generation based on hydroelectric power plants in Uzbekistan decreased by 23% compared to the previous year due to lack of water. This situation was observed not only in Uzbekistan, but also in the countries of Central Asia [1]. At the same time, over the past two years, Uzbekistan has resumed

the import of electricity from neighboring countries of Central Asia to meet the needs of the population and industry at peak load, especially in winter [2].

According to the Ministry of Energy, according to the concept of the Republic of Uzbekistan, by 2030, the growth of electricity consumption in Uzbekistan is expected to reach 110 billion kWh. The concept provides for an increase in the share of renewable energy sources (NRES) in electricity generation in the country from 11 percent by 2030. It is determined that 5% of it is brought by the sun, 3% by the wind and 3.8% by hydropower [3].

Due to the fact that the slopes of the main parts of water sources such as rivers, channels, channels and irrigation systems in the world are small, the construction of small hydropower plants in them will cause damage to large areas of cultivated land and environments. In such places, there are many places where you can create a water pressure in the range of low 1.5-5 meters, where you can build and use thousands of micro hydroelectric power plants [4-6].

It is known that most of the existing rivers, canals and hydro sources in our region have a low head. Today, almost all over the world there is a special interest in the use of this hydropower potential for the production of electricity, and at the same time, hydropower is seen as an urgent task. Efficient use of environmentally friendly sources of hydropower is also one of the priorities of the country's economic development [7].

In the work carried out, the main part of micro HPPs using the water flow rate of a low-pressure turbine is made up of buckets, propellers, propeller parts, and their improvement is aimed at changing the angle of impact of water on the blades and changing the surface curvature or geometric shapes of the blades, as well as their focus on determining the optimal values of their sizes [8-14].

Methods. If you dwell on active hydro turbines designed to operate in a low-pressure water flow, you can see their pros and cons. For example, in [15], a catamaran-type floating hydraulic device with unstable operation was developed to change the water flow. [16] During operation, vane gearboxes transmit movement independently of each other to a vertically or horizontally mounted shaft through gears. This device has very large dimensions, and also works unstably when the amount of water flow changes. Also in scientific papers [17–21], large-sized active hydraulic turbines with low water consumption and low pressure and water wheels of 2–3 m were developed. Due to the high cost of low-speed, multi-pole generators, they are rarely produced in industry [22]. This situation leads to the use of gearboxes or multiple cascaded pulleys, resulting in wasted energy. As a result, the efficiency of the micro power plant decreases.

Existing designs of jet turbines (radial axial, propeller, with rotating blades, two-bladed) are characterized by efficient operation at heads of more than 4–5 m [23–24].

An analysis of information sources on hydraulic turbines shows that jet turbines have a significant drawback, that is, their efficiency changes dramatically with load changes, and a high efficiency zone is observed only in a narrow range of power changes. This disadvantage significantly reduces the efficiency of jet turbines when used in energy-deficient systems [25]. At low pressures, the efficiency of these turbines is sharply reduced, which gives unsatisfactory results at low pressure water flows.

In conclusion, from the above, it has become clear from the studies of jet turbines developed to date that the nozzles attached to the impeller of a jet turbine mainly have the geometric shapes shown below in Figure 1. They can be made from round or rectangular tubes.

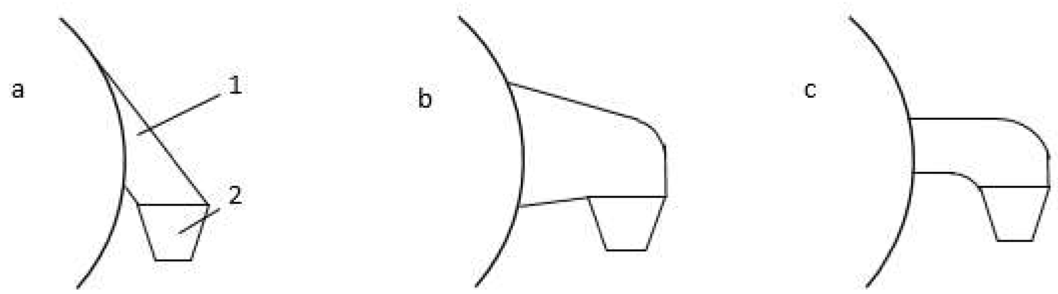

Figure 1. General scheme, top view of the hydro turbine nozzle nozzles. 1- nozzle water intake channel; 2- conical drainage channel

In works [8-11], the water nozzle shown in Fig. 1-a), consists of two parts, consisting of an inlet channel 1 and an outlet channel 2. In it, the water flow leaving in the radial direction is directed towards the inner wall of the water intake channel, under the influence of the linear speed of the rotational movement of the impeller, the water flow is slightly directed towards water outlet channel. However, the flow of water leaving the divertor practically returns in the radial direction due to its high absolute velocity. As a result, the water beams leaving the guide vane and returning from the inner wall of the nozzle interact with each other, creating a low-speed water flow inside the nozzle, which is in uneven non-uniform motion. This water flow is directed to the outlet channel under the action of water pressure. Due to the low speed of the water, the reactive force generated in the nozzle is small. In other words, due to such movement of the water flow, energy losses are observed. b) in the nozzle in the figure, the water jets returning from the inner wall at the nozzle inlet move towards the extreme points of the nozzle in the radial direction. At the center and bottom of the nozzle inlet, the flow to the nozzle is influenced by a second return flow from the top of the nozzle. In this case, as mentioned above, there is a loss of energy. In this case, the component of the impact force of the water column on the inner wall of the nozzle is acting perpendicular to the radial direction and the reactive force is equal to the change in the momentum of the water leaving the nozzle. rotated 90° to the outlet channel. In this case, the angle of rotation is equal to the drag coefficient ξ_{90}=1,25according to the formula of I.V. Semikin [12]. If the turn is at a large angle, a straight turn occurs, the energy loss is reduced. The reactive power generated in this nozzle is equal to the change in the momentum of the water jet emerging from it.

In works [13-14], they were carried out on a jet turbine with nozzles, but the change in the number of nozzles depending on the size of the impeller, as well as the method for determining the geometric shape, the dependence of its dimensions on the dimensions of the turbine does not light up. The general scheme of the top view of the horizontal section of the impeller of the hydraulic turbine is shown in fig. 2.

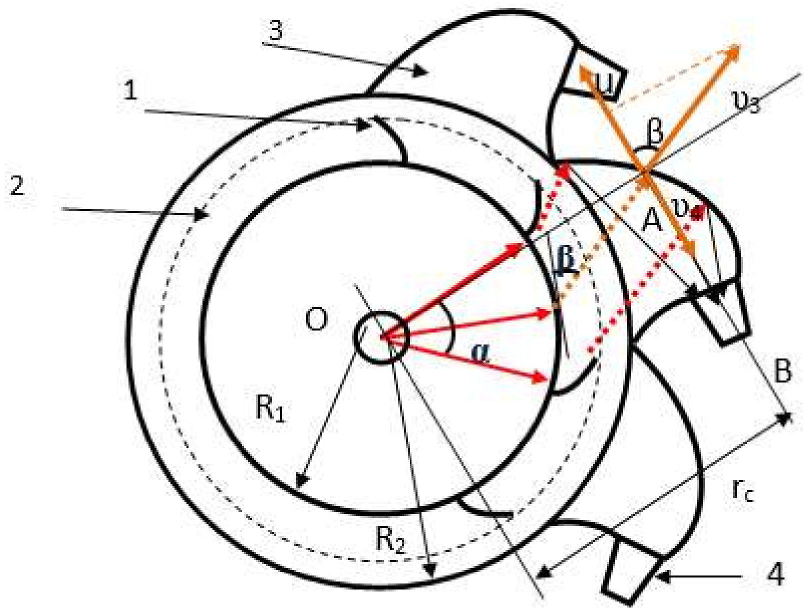

Figure 2. Top view of the horizontal section of the jet nozzle hydraulic turbine impeller [6]

On fig. 2 shows how part of the water entering the impeller nozzle with a speed of υ_3 interacts with point A and leaves the nozzle with an absolute speed of υ_4. The flow of water in a vertical pipe of radius R_2, spreading from the center along the radius, is directed to the water intake channel of the nozzle 3 through the 1st guide vane. Let the absolute speed of the water entering the nozzle υ_3 the linear speed of a point at a distance R_2 from the center of the cylinder be equal to u at dynamic equilibrium.

The water flow with speed υ_3 hits the inner walls of the nozzle 3 at an angle φ relative to the normal to it. As a result of the impact, a reactive force acts on the impeller in the direction of the speed u, proportional to the cosine of the angle. The water flow returning from the inner wall of the nozzle exits the nozzle through a conical baffle with a cone angle of 30°-35°. To calculate the reactive force FA created by water leaving the impeller nozzle, the change in the momentum of the incoming and outgoing water in it is determined, and the force acting on the nozzle at point A is expressed as follows [13]:

$$F = \rho S_3 \upsilon_3^2 \left(\cos\beta + \sqrt{\frac{S_3}{NS_4}\left(1 - \frac{S_3}{S_4}\right) + 1 - \frac{1}{2}(\xi_{S6} + \xi_2)}; \right); \quad (1)$$

This design power is the power generated by a single nozzle and is determined by multiplying the total reactive power by the number of nozzles.

It can be seen from formula (1) that the reactive force generated in the nozzle, the speed of the water leaving the nozzle, depends on the installation angle of the guide shovel relative to the radial direction β. The geometric shape of the nozzle ensures the angle of impact of the water jet against the inner walls of the nozzle and the direction of the nozzle back to the exit window of the water in such a way that the directed water flow creates a reactive force due to the uniform rotation in the nozzle. In accordance with the pressure and flow of water in these hydraulic turbines, the

geometric dimensions and number of nozzles change. Depending on its geometric shape, its energy parameters also change. When the location of the water flow inlet to the nozzles along the perimeter of the impeller and a large distance between the nozzles, energy losses are observed as a result of the resistance of the water inlets and the influence of the walls of the working cylinder.

Results. Let the number of nozzles on the impeller of the hydraulic turbine be *m*. If the number of vanes located along the arc formed by one nozzle is equal to n, then the central angle between the two vanes corresponds to $\alpha = \frac{2\pi}{mn}$. Based on this, we will develop a method for determining the geometric shape of one nozzle. To do this, it is necessary to determine in advance the geometric dimensions of the impeller and guide device. Let us assume that a diversion device designed for water flow Q is attached to a supply cylinder with a diameter of d_2, a shovel of length ℓ_k direction is attached to the radial direction at an angle of *β* to the radial direction, and the water flow in nozzle mixers consumes the least energy in flat compression let the taper angle χ=30°-35° degrees [12].

The number of hydro turbine nozzles can be 2 or more. Below is a schematic drawing of a part of the impeller with four nozzles in the OXY plane (Fig. 3).

To determine the geometric shape and dimensions of the nozzle, initial conditions are needed. We include these conditions depending on the water flow and water pressure in the hydraulic turbine.

The radius of the feed cylinder of the hydraulic turbine R_1, the water flow Q is constant Q=const and the water pressure H, the relationship between which is as follows:

$$R_1 = \sqrt{\frac{Q}{\pi\varepsilon\varphi\sqrt{2gH}}}; \qquad (2)$$

where φ is the water loss coefficient of the nozzle at the water inlet to the supply cylinder; ε is the ratio of the surface of the wetted perimeter of the water flow in the cylinder to the cross-sectional surface of the pipe. For injectors of medium quality $\varepsilon\varphi = 0.9$, you can get $\varphi = 0.95$ [15].

When the radius R_2 of the guiding cylinder is equal to the radius of the feed cylinder, the energy loss due to energy expansion (compression) is minimal. The inner radius of the guide cylinder, taking into account the wall thickness, is equal to $R_2 = 0.98R_1$. For the length of the guide vane, determined depending on the inner radius and its height in the radial direction, the following results were calculated:

$$\ell_k = \frac{R_2}{6\cos\frac{\pi}{m}}$$

$$h_k = R_2\left(\frac{\sin\frac{\pi}{m}\cos\beta}{\cos^2\frac{\pi}{m}} - \sqrt{tg^2\frac{\pi}{m} + 2(1-\cos\frac{\pi}{m}) - 2tg\frac{\pi}{m}\cdot\sqrt{2(1-\cos\frac{\pi}{m})}\cdot\cos\frac{\pi}{2m}}\right) \qquad (3)$$

Impeller cylinder outer radius R_s, guider radius R_2, guide vane radial height h_k, distance between shovel and impeller cylinder inner wall δ and cylinder wall thickness b_s will add up:

$$R_S = R_2 + h_k + \delta + b_S; \tag{4}$$

By changing the diameter of the impeller of this hydraulic turbine to the size of the nozzle, it can be made of any size, but an increase in diameter leads to an increase in the moment of inertia about its center and a sharp decrease in the rotational speed. It is also necessary to use additional transmission parts. As a result, the efficiency of the hydro turbine will be low. To avoid these shortcomings, it is necessary to determine the optimal dimensions of the nozzle parts of the impeller. To do this, it is necessary to determine the rotational speed ω, suitable for the generator selected for the hydro turbine. The rotational speed depends on the speed of the water flow υ_3 entering and leaving the hydro turbine nozzle υ_4. The distance from the center of the water outlet from the nozzle to the center of the impeller r_0 is the force arm, and the optimal value of this force arm is determined by the water flow rate υ_3 entering the nozzle:

$$r_0 = \frac{1}{3\omega_Z}\left(t + \frac{1}{t} + 1\right); \tag{5}$$

this includes the following definitions:

$$t = \sqrt[3]{\frac{27\omega_Z^2 c + \sqrt{(27\omega_Z^2 c + c)^2 - 4} + 2}{2}};$$

$$c = \frac{S_3 \upsilon_3^2 (\cos\beta + \sigma)}{\pi \upsilon_4}; \qquad \sigma = \sqrt{\frac{S_3}{S_4}\left(\frac{S_3}{S_4} - 1\right) + 1 - \frac{1}{2}(\xi_{SK} + 1.25)};$$

In this case, the absolute velocity of the water jet leaving the nozzle is calculated by the following formulas [16]:

$$\upsilon_4 = \upsilon_3 \sigma$$

$$\upsilon_3 = \frac{\ell_k m \upsilon_2 \sin\alpha_1 \sin\beta}{2\pi R_2^2} e^{i(\alpha_2 - \beta)} + \upsilon_2 e^{i(\alpha_2 - \alpha_1)};$$

$$\upsilon_2 = \frac{\varphi}{R_2^2}\sqrt{2gH\left(R_1^4 - R_1^2 R_2^4 + R_2^4\right)};$$

$$\zeta_{SK} = 0{,}125\lambda \cdot \left(1 - \left(\frac{S_4}{S_3}\right)^2\right); \tag{6}$$

Here S_3, S_4 are the surfaces of the inlet and outlet of water from the nozzle, respectively; α_1 and α_2 are the angles of water entry and exit to guide vanes, respectively; β - installation angle of the guide vanes with respect to the radial direction; λ - Darcy coefficient.

The Darcy coefficient is determined depending on the degree of tortuosity of the pipe and the Reynolds number. Fluid flowing in turbulent mode in a smooth pipe with steady flow ($10^5 \le \mathrm{Re} \le 10^8$). The Darcy coefficient is determined by the Nikuradze formula [12; 160-b]:

$$\lambda = 0{,}0032 + 0{,}22 \cdot \mathrm{Re}^{-0{,}237} \tag{7}$$

The speed of the water jet leaving the deflector blades before entering the nozzle is reduced due to the expansion and resistance of the blades. Its absolute speed must be

increased as much as possible so that the jet of water coming out of the nozzle acts on the nozzle with a large momentum of force. Therefore [13; 98-100 pp.], a condition has been developed for optimizing the ratio of the water surface entering the nozzle to the surface of the water leaving it. In it, the water intakes of the hydraulic turbine feed cylinder and nozzles are made round, and the following ratio is obtained between their surfaces:

$$\frac{S_2}{S_c} \geq \sqrt{\zeta_{90^0} - \zeta_{SK}}\ ; \qquad \xi_{90} = 1{,}25\ ; \tag{8}$$

where S_s - exit from the nozzle - cross-sectional area;

ξ_{90} - coefficients of water resistance when rotated by 90° and ξ_{SK} - reduced section in the nozzle cone.

Determine the ratio of the water inlet and outlet surfaces of one nozzle as follows:

$$\frac{S_3}{S_4} = k \tag{9}$$

Taking the value k equal to 2 gave good results in the experiment [26]. leads to an increase in speed by a factor of 2 in accordance with the continuity equation. Increases its value by reducing water consumption and increasing seal mobility due to local resistance. This results in reduced efficiency.

This condition also applies to our case. And S_3 is determined by the arc length A_7N_0, where one nozzle is drawn into the working cylinder (Fig. 3). *p* percent of the entire length of the arc is occupied by the nozzle A_7A_6 hardening part to the working cylinder. The remaining *1-p* percent is water input. The height of the water intake of the nozzle is equal to the height of the guide vane L. In this case:

$$S_3 = (1 - \frac{p}{100})\frac{2\pi}{m}R_S L; \qquad 10)$$

Using the continuity of water flow and (9), we determine the surface S_4:

$$S_4 = kS_3\ ; \tag{11}$$

x nozzle outlet width:

$$x = k\left(1 - \frac{p}{100}\right)\frac{2\pi}{m}R_S\ ; \tag{12}$$

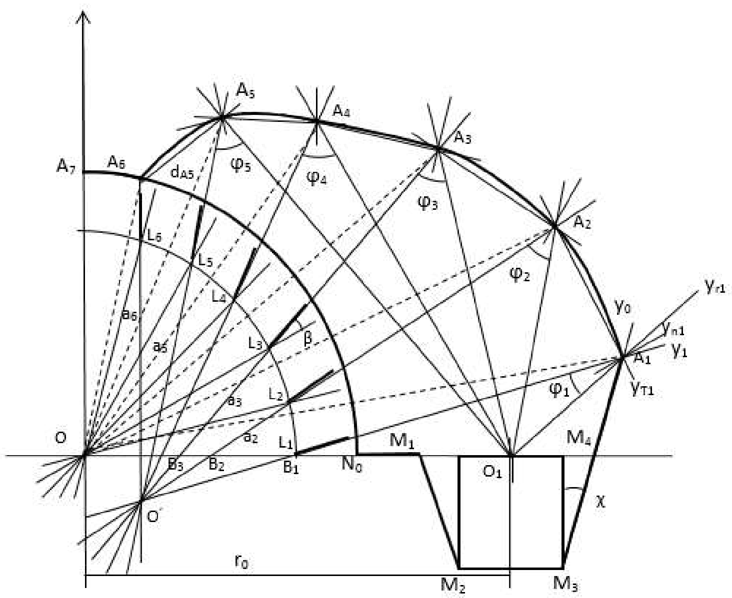

Figure 3. Method for creating the geometry of the nozzle impeller nozzle

Discussion. The force expressed by formula (1) is determined by the difference in momentum of the water jet entering and exiting the nozzle. In order for this force to reach its maximum value, the angle between the directions of the absolute velocities of the water flow entering and exiting the nozzle must be as large as possible and close to 180°. In this case, the jet of water coming out of each guide vane must be compressed in a straight line towards the outlet window. To analyze this situation, we divide the water flow from the nozzle guide vanes into separate small water bundles. In this case, we can assume that it obeys the law of geometric optics, neglecting the viscosity of water. Because if we assume that there is no viscosity between the molecules in the liquid layer, then they behave like an absolutely elastic body, while the water layer also obeys this law. Based on the foregoing, we introduce the appropriate conditions for the trajectory of the water jet, i.e. - the water flow from the guide vanes must hit the inner walls of the nozzle so that the water jet returning from the wall at an angle φi is directed towards the outlet window of the nozzle, without intersecting with neighboring jets of water. In this case, the water column, as it were, leaves the point O and goes to the inner wall of the nozzle (Fig. 3).

In the initial position, the top view of the confuser forms a trapezoid $M_1M_2M_3M_4$. Let the cycle frequency of a hydraulic turbine operating in a water source with a water flow rate Q and a head H be equal to ω, and the center of the water outlet of the corresponding nozzle be equal to O1. Distance from the center of the impeller to point O_1 r_0, spillway width in the radial direction $M_2M_3=2\ell_0$, $M_1M_4=4\ell_0$, $V_2M_4= \ell_0$ and nozzle cone angle baffle $\angle M_3= \chi$ Symbol χ input, A_i point identification work in progress on the next steps.

Let the water handle L_0N_0, L_1N_1, ... L_nN_n be directed to the points A_0, A_1, ... A_n through guide vanes. Let the water beams returning from these points arrive at the point O_1 of the nozzle. Then from Fig. 3 shows that if the coordinates of the points A_0, A_1, ... A_n are defined, then the curve passing through these points determines the shape of the top view and the geometric dimensions of the nozzle edge. Considering the coordinates of these points as a straight line, one can construct the equations of each straight line in the Cartesian coordinate system and determine the coordinates X_{Ai} and Y_{Ai}, respectively. In this case, taking a large number of spades along an arc corresponding to the angle occupied by the nozzle gives a good result for creating a straight curve of the geometric shape of the nozzle.

Conclusions. Based on the results obtained, the height of the designed nozzle in the radial direction decreases with an increase in the number of nozzles. Because the arc drawn into the central corner that the nozzle should occupy becomes smaller. As a result, the radius of curvature of the curve formed by connecting the points A_0, A_1, ... A_n, decreases. Based on these results, by changing the number of nozzles, it will be possible to control and calculate the power arm of the impeller, that is, the torque.

The diameter of the water supply cylinder of the hydroturbine is increased in places where it is planned to work in sources with high water consumption and low pressure. This situation leads to an increase in the diameter of the impeller. Exceeding the critical value of the impeller diameter leads to an increase in the moment of inertia and a decrease in the speed of the impeller. This, in turn, causes excessive energy losses due to the use of additional pulleys or gearboxes.

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ANALYSIS OF SOLAR ENERGY DEVICES

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Abstract: Analytical research on the effective use of solar energy in the conditions of Uzbekistan was conducted in the article. It was mainly analyzed that solar energy devices are more effective in using them according to their goals. The article contains theoretical conclusions based on the results of the research methods used in the literature. The data was analyzed using the "Methodological analysis" and "Meta-analysis" methods.

Keywords. solar air heater, solar water collector, tower solar power plant, parabolic cylindrical solar thermal power plant, solar photovoltaic panel.

Introduction. Currently, in order to meet the demand of energy consumers, nature is being damaged due to the use of organic fuels in the world. As a result, new types of diseases are appearing in the human and animal world (land and water). In addition, the sharp reduction of organic fuel reserves leads to an increase in indicators of the shortage of energy resources in various fields. Therefore, one of the main problems facing humanity is to provide energy consumers with environmentally friendly energy. Environmentally clean energy can be obtained only from energy sources that exist in nature and do not emit harmful gases and waste as a result of their use [1-23].

Methods. The use of solar energy is an unlimited source of energy for the planet earth. At present, scientific research is being conducted to achieve efficient use of solar energy based on the use of new technologies using various methods. In theory, solar energy has the potential to adequately meet the energy needs of the

entire world. An average of four million exa-joules of energy reaches the earth per year (EJ=10^{18}J). Approximate calculations show that 5×10^4 EJ of the total solar energy can be conveniently used [2].

One of the main reasons for increasing the use of solar energy is related to the efforts aimed at reducing global carbon emissions, which have become an environmental and socio-economic problem in the main world in recent years [3].

Expanding the scope of use of energy devices operating on the basis of renewable energy sources is not only one of the main goals of the Republic of Uzbekistan, but also one of the main issues for the countries of the world. This necessity arises from the need to save primary energy reserves, guarantee the country's energy security, and improve the living and social conditions of the population [4].

The total area of Uzbekistan is 448.9 thousand square kilometers, 70% of its total area is occupied by deserts. It is located in a favorable climate for the use of solar energy (37° to 45° north latitude and 56° to 73° east longitude). Solar energy makes up 98.5% of the total renewable energies and therefore serves as the main factor in planning the share of renewable energy use in the total energy balance of the Republic [5].

The main renewable energy sources in the Republic of Uzbekistan are solar, hydropower, wind, geothermal and biomass. The total technological potential of the Republic in terms of existing renewable energy sources is 179.4 million tons of oil equivalent. This is almost 3 times more than the current energy demand of the country [6].

The amount of solar energy reaching the earth's surface is large, reaching one kilowatt per square meter in the summer season in the middle regions. Solar energy can be used with photovoltaic panels, parabolic solar collectors, heliostat tower solar collectors, solar Sterling engines, solar water heating collectors, and solar air heaters [7].

Scientific researchers conducting scientific research are conducting scientific research on the introduction of energy-efficient, economically efficient, environmentally friendly energy-based modern technology and equipment into heat energy supply networks [8].

Taking into account that the natural fuel and energy reserves used by the economic sectors are rapidly decreasing, the use of renewable energy sources is the basis for saving natural resources and keeping the natural ecological situation unchanged from negative aspects.

One of the main energy problems faced by world scientists in the 21st century is the development of an environmentally friendly and high-potential energy supply system. Because all types of energy reserves of all types of existing primary energy sources are short-lived, it is considered that the level of bringing big problems related to energy reserves in the near future is high [9].

The use of solar energy is effective in the climatic conditions of Uzbekistan. In particular, the gross potential of solar energy is equal to 50973 million tons of oil equivalent [1].

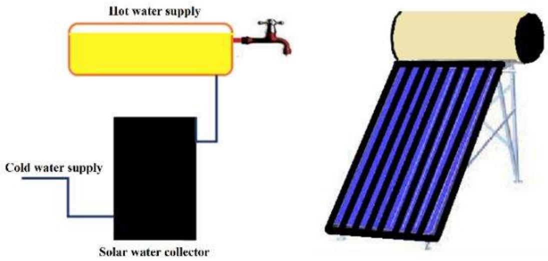
By now, solar energy has reached the level of widespread use in industrial production, household life, small production, processing enterprises, service places, horticulture, fisheries and almost all industries. Technologies for converting solar energy into heat and electricity, necessary for all industries, have been created, and scientific research works are being carried out in the directions of their further development, lowering the cost, extending the service life, simplifying use, and increasing efficiency. The technologies of conversion from solar energy to thermal energy are considered to be one of the fastest developing directions in recent

years. A hot water system using solar energy is called a solar collector.

A solar photovoltaic panel is a system of obtaining electricity based on solar energy. The system for obtaining hot air based on solar energy is called a solar air heater. The hot water system based on solar energy is implemented using solar collectors. The principle scheme of solar collectors is shown in Fig. 1.1. Solar collectors are divided into direct and indirect working groups. Directly working solar collectors (Fig. 1.1a) heat the metal on the working surface based on solar energy, and the temperature of the water increases due to the heat transfer of the metal. Such systems cannot be used in winter seasons, that is, when the air temperature is below 0 C^0. In solar water heaters working with a motor, substances with a low freezing temperature are used as a working substance. For example, it can be used in antifreeze [7].

Vacuum tubes are widely used in modern solar water heaters. Vacuum tubes use solar energy to heat a metal made of high thermal conductivity material in the center of the tube, and the metal uses heat energy to heat water in a thermally insulated water tank. There are various schemes of such solar collectors, from a simple construction to a complex one.

The first generations of solar collectors have been used for a long time. Such methods are related to people putting water in a container in the sunlight and heating it. Solar collectors are still widely used in a simple form, especially in rural areas, where hot water is obtained by painting large water tanks black.



a) b)

Figure 1.1. The principle scheme of the solar collector

Solar collectors are divided into two systems depending on the forced and natural form of movement of the working substance. Active and passive systems. In active systems, the working substance is forced to circulate with the help of a pump. In passive systems, natural circulation is implemented. In addition, mixed systems of solar water heaters are also used. Such systems heat cold water to a certain extent with the help of a solar collector, and heat it by spending additional energy to bring it to the desired temperature [7].

Using solar water heaters in many countries, it is possible to provide about 85% of the demand for domestic hot water. In addition, it is a safe system, it can be used in areas where there is no electricity or during power outages. It is possible to save energy from 40% to 80% by replacing the existing electric and fuel hot water systems with solar water heating systems.

Globally, the main countries that effectively use solar water heaters are Figure 1.2 [10].

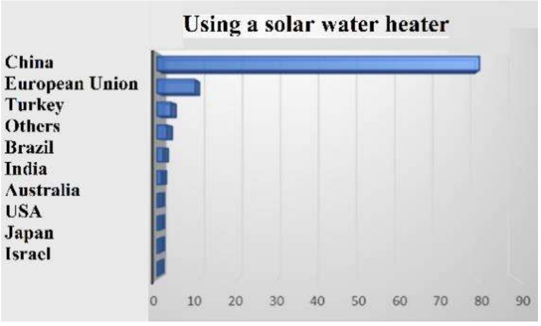


Figure 1.2. Major countries with extensive use of solar water collectors

The conversion of solar energy into electrical energy using photovoltaic panels is carried out using semiconductor elements. The system of obtaining electricity using solar photovoltaic panels is based on the principle of photovoltaic effect. The principle of photovoltaic effect was first observed in 1839 by Alexandre Edmond Becquerel. Currently, scientific research is being carried out to increase the efficiency of solar photovoltaic panels and reduce their cost. Silicon is one of the most common semiconductor materials. Silicon is currently the main material in the production of photocells. The price of pure silicon is expensive because the technology of extracting pure silicon is very complicated and requires a lot of money. In addition to silicon, solar panels are also produced from materials such as copper, indium, selenium, gallium, and cadmium. Figure 1.3 External appearance of a solar photovoltaic panel.

Figure 1.3. Solar photovoltaic panel

The efficiency of standard solar panels produced today is around 20%. And some panels are produced based on two-way energy capture. According to the results of approximate calculations, porobolosindrik solar thermal power plants would meet the demand for electricity of the whole world if one percent of the Sahara Desert was used. The construction of solar thermal power plants in equatorial countries will cause a sharp drop in the price of electricity. The principle of operation of parobolosylindrical solar thermal power plants is not based on the photoeffect phenomenon. Its principle of operation is mainly based on heat processes. Three main types of solar thermal power plants are developed.

-Porobolosylindrical solar thermal power plants;

- Tower solar thermal power plants;

-Solar thermal power plants based on the Stirling engine.

In porobolo-cylindrical solar thermal power plants, the temperature of the working substance is sharply increased in the pipes located in the center of the porobolo-shaped solar concentrator. A solar thermal power plant with this principle of operation was first created in 1906 in the

USA and built and tested near Cairo, Egypt. The first commercial thermal power plant was built in 1984. After the oil crisis, during 1984-1991, a thermal power plant with such a working mode was built in the Mojey desert of the California state of the United States of America. The total area of 6 km2 was needed for the thermal power plant built in the Mojai desert. The installed capacity of the thermal power plant is 354 MW [7].

Porobolosylindrical solar thermal power plants can be used in their pure form in equatorial countries. In other regions, it is appropriate to use it as a mixed system. In pure thermal power plants, energy is obtained only on the basis of solar energy (Fig. 1.4). In mixed systems, along with solar energy, other fuels are used (Fig. 1.5).

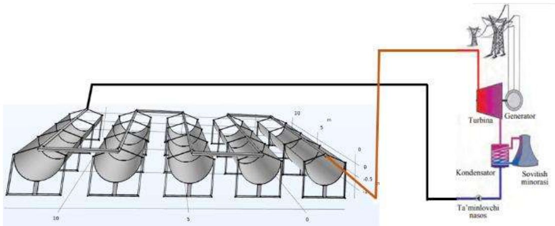


Figure 1.4. Pure porobolosylindrical solar thermal power plant

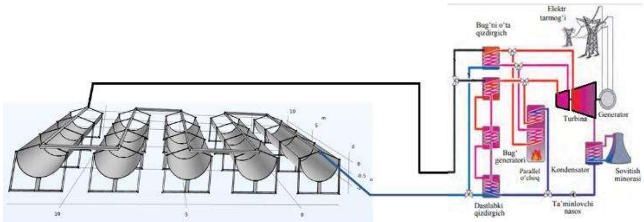


Figure 1.5. Mixed porobolosylindrical solar thermal power plant

The use of solar thermal power plants of this type in the climatic conditions of Uzbekistan has a great effect, taking into account the sharp reduction of fuel reserves and the increase in the cost of fuel. Electricity generation using tower solar thermal power plants is carried out by collecting a large area of sunlight energy in a small area energy receiver located in the tower. Solar thermal power plants of this type are now widely used in Spain, USA, Israel, Germany and other countries [18].

Solar energy is transferred to the receiving device located in the tower using reflective mirrors (heliostats) (Fig. 1.6).

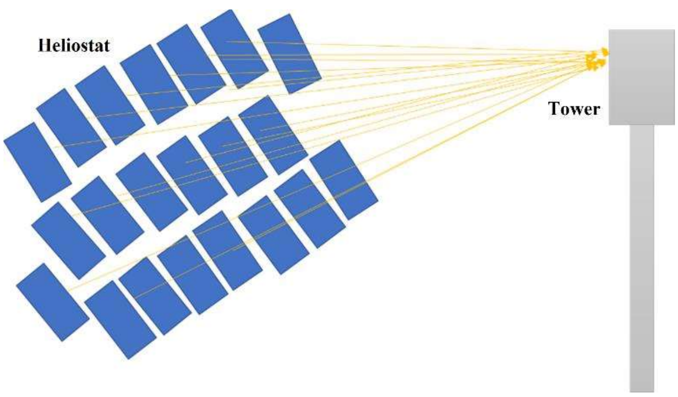


Figure 1.6. Tower solar thermal power plant

The system of converting solar energy into electricity using the Sterling engine is used in developed countries. The conversion of solar energy into electrical energy using the Sterling engine is carried out in the form of a porobolo solar concentrator. The engine moves due to the expansion of the working substance inside the hot piston of the Sterling engine due to the accumulated heat energy. Mechanical energy is extracted from thermal energy and mechanical energy is converted into electrical energy using a generator [11, 13].

Figure 1.7. A system of generating electricity from solar energy using a Sterling engine

The system of obtaining thermal energy using solar air heaters is one of the developing systems. Solar air heaters can be effectively used in homes, greenhouses, industries, manufacturing enterprises, dormitories and many other places. The solar air heater device increases the temperature of the absorber surface on the basis of solar energy, and the solar air heater works by transferring the heat from the high-temperature surface to the consumer. Convection process is natural and forced. For efficient use of solar air collectors, it is necessary to place the device perpendicular to the sunlight. In addition, the efficiency of the device depends on many factors. The use of solar air heaters in the spring and autumn seasons is very beneficial for our country. The efficiency of solar air heaters can be increased depending on the accelerating elements placed on the surface. In this case, it is necessary to select the accelerating elements in the device, depending on the dimensions of the device, such as height, length and width. In addition, it is necessary to pay special attention to the location, height, shape and smooth passage of air. Accelerating elements in the device cause an increase in hydraulic resistance, which in turn causes a drop in pressure. Determining the efficiency of the device is carried out by determining the balance of pressure loss, heat gain and hydraulic resistance [12,21,22,23].

Figure 1.8. External view of the solar air heater

Results. The main common types of solar energy devices were analyzed based on the results presented in the articles. The change in the efficiency of solar energy devices depending on the location and location angles was studied based on the analysis of the literature and the factors affecting the efficiency of the solar energy structures were determined based on the analysis of the literature [12-23].

Discussions. In the analysis of solar energy devices, it is possible to take into account the solar energy potential of the region when using all devices and observe changes in the technical indicators of devices under the influence of external factors.

Conclusion. When using solar energy devices, it is effective to use different devices based on the purpose:

- The use of solar water heaters for hot water supply is appropriate, the use for the purpose of heating buildings leads to a sharp decrease in efficiency;
- Centralized (not individual) use of steam-cylinder solar thermal power plants is appropriate;
- The use of solar photovoltaic panels in a battery-free system is economically efficient;
- The system of obtaining electricity from solar energy using the Sterling engine has a complex construction compared to other systems;
- The use of solar air heater collectors for heating buildings and structures is economically and energetically efficient.

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UDC 620.92

DETERMINING COMPARATIVE EFFICIENCY IN COMPOSITE FILM SOLAR DRYERS

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Abstract:

Objective. For the development of mobile structures of solar drying devices, it is proposed to use a composite film developed on the basis of functional ceramics as a transparent wall. Determination of comparative efficiency in terms of drying speed of products in each device on the basis of experimental studies on drying of fruits and vegetables in drying devices. To provide suggestions, explanations and conclusions based on the conducted research.

Methods. In the drying chamber, the conversion of solar radiation, i.e. exposure to the pulse to dehydrate the product to be dried by generating infrared rays.

An empirical formula for determining the dynamics of drying in radiation drying devices has been developed.

Results. Using the results of research conducted on drying devices, the comparative drying efficiency of devices for each product was determined.

Conclusion. Based on the research conducted on the drying of apples, grapes, cherries, onions and carrots in drying devices, the comparative efficiency and drying speed of the Composite-1 film solar drying device were found to be 25% to 67% more efficient than the traditional film solar drying device. Also, in the final stage of drying of products, the differences in safe moisture content determined by each device are presented, and an empirical formula for determining the dynamics of drying in radiation drying devices and a methodology for its use are developed.

Keywords: Composite-1 film, composite-2 film, conventional film, direct, comparative efficiency, speed, product.

Introduction. Since drying is now an important part of daily activities, this activity has become an integral part of many processes around us. Solar dryers have been developed in different sizes and designs depending on the requirements of different types of products to be dried. Among them, the simplest and cheapest type are direct, radiation solar dryers.

Working principle of direct solar dryers – In this type of solar dryers, sunlight falls directly on products placed in a chamber with a transparent wall. The relative humidity of the air decreases in the drying chamber. As a result, the moistened air is expelled from the chamber naturally or with an artificially created pressure difference. Dryers of this type are installed in places where there is no possibility of receiving direct sunlight during the main part of the day [1, p. 463].

Directly in the dryers, as a transparent body, for example, glass, various transparent plastics and polyethylene films are covered, which provides short-wave radiation, the light passing through the transparent body turns into long-wave radiation and increases the temperature of the air in the dryer. The materials used for the transparent coating usually do not allow long-wave solar radiation to escape. However, it is recognized that polyethylene films are less durable than glass, which means that polyethylene films are constantly adversely affected by wind and sun [2, p. 623].

Indian scientists conducted thermal modeling and experimental investigation of

solar tunnel dryer. The tunnel dryer is covered with a 200 μm UV-stabilized plastic sheet and operates in free convection mode. The experimental energy and exergy efficiency of the drying chamber was found to be from 2.72% to 28.01% and from 69.43% to 90.76%, respectively [3, p. 211].

Indian scientists tried to evaluate the performance of a dryer developed for drying grapes. The study found that untreated grapes took seven days to dry at 16% (wb) moisture. The temperature gradient inside the tunnel dryer was about 10-28 °C during the open day. It was found that drying in open sun took more than 11 days [4, p. 269].

Indian scientists have developed multi-storey house-type solar dryer for drying vegetables. The relative humidity inside the dryer varied from 21% to 74% compared to the outdoor environment of 40% to 75%. The temperature inside the dryer was 62% to 76% above ambient conditions. dryer drying time reduction from 33% to 53% was achieved [5, p. 290].

Below is the comparative performance of proposed solar dryers using natural convection functional ceramic based composite films.

Methods. The mechanism of converting solar radiation energy into a pulsed infrared spectrum and effectively affecting the product is presented in detail in [6,7,8,9,10,11].

Empirical formula for determining drying dynamics in radiation drying devices was developed. This formula makes it possible to evaluate the drying efficiency of the device on the firs.

$$M_2 = \frac{1}{k}\frac{M_1 \lambda M_3}{tSI} \qquad (1)$$

M₂– residual weight (kg), *M₁*– initial product weight (kg), *λ*– average specific heat of vaporization of water (J/kg), *M₃*– total sugar content (kg), *t*– drying time (Seconds), *S* – the surface of the solar radiation receiving device (m^2), *I*– average daily value of cumulative solar radiation flux ($J/m^2 sec$), *k*– drying coefficient.

Based on the empirical formula (1) above, the dynamics of construction of various products were determined, and the reliability of the formula was evaluated based on experimental studies.

For a detailed analysis of the comparative effectiveness of solar dryers with composite film, the results of experimental studies on drying products such as apples, grapes, cherries, vegetables, onions, tomatoes, and carrots are presented.

$$\eta = \left(\frac{\tau_1}{\tau_2} - 1\right) \cdot 100\% \qquad (2)$$

Based on the following expression, the relative efficiency of the devices in terms of drying speed is determined.

Here:

τ_1 – drying time until final drying, (hours, days)

τ_2 – time spent until final drying in an efficient drying device, (hours, days)

Results and discussions. The final drying results of apple drying are presented in Table 1 below[11,12].

Device type	Drying time, day						
	0	3	4	5	6	7	8
	Residual mass, %						
Composite-1	100	16	16	15	15	15	15
Traditional	100	19	18	18	18	17	17

Based on the data presented in Table 1 above, the relative efficiency in terms of drying speed was determined using expression (2).

In devices for drying apples, the final residual mass was 15% of the initial poured product. This value was reached in 5 days by the drying device using Composite-1 film according to Table 1. A drying device using conventional film reached 17% value in 8 days. The observed difference in drying rate between these two devices was 40% based on expression (6). As a result, when drying an apple with an average diameter of 3-4 cm in 4 parts to reach the final safe moisture, the drying device using Kompozit-1 was able to dry 40% faster than the drying device using traditional film.

Table 2 below shows the results of grape drying in drying devices[12,13,14].

Table 2

Device type	Drying time, day								
	0	16	17	18	19	20	21	22	23
	Residual mass, %								
Composite-1	100	24	23	23	23	22	22	22	21
Traditional	100	28	27	26	26	26	25	24	24

Based on the data presented in Table 2 above, comparative efficiency in terms of drying speed was determined.

When the residual mass is 24% of the initial poured product for drying grapes in the devices. This value was reached in 16 days by the drying device using Composite-1 film according to Table 2. A drying device using conventional film achieved this in 23 days. As a result, when drying grapes, the drying device using composite-1 film achieved 44% faster drying compared to the drying device using conventional film.

Table 3 below shows the results of a study on cherry drying [15].

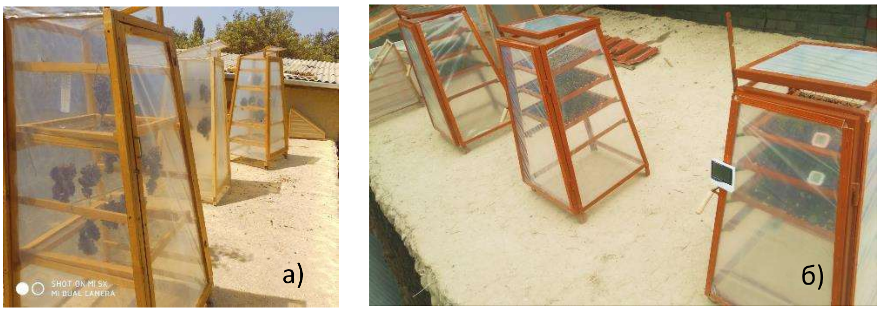
Table 3

Device type	Drying time, day								
	0	10	11	12	13	14	15	16	17
	Residual mass, %								
Composite-1	100	45	40	37	33	30	27	25	25
Composite-2	100	46	41	35	34	28	26	24	23
Traditional	100	44	40	35	31	28	25	24	23

Based on the results presented in Table 3 above, the comparative efficiency in terms of drying speed was determined.

In the devices for drying cherries, the residual mass was 25% of the original poured product. This value was reached in 15 days by the drying device using Composite-2 and Conventional film according to Table 3. This result was achieved in 17 days in a dryer using composite-1 film. There was no significant difference between the two devices with Composite-2 and Conventional film in terms of drying speed.

When comparing the drying speed of the drying device using the traditional film with the



drying device using the Composite-1 film, the efficiency of the devices was 13%.

a) drying of grapes is described, b) drying of cherries is described.

Figure 1. Experimental process

Below, the comparative effectiveness of drying vegetables in composite and traditional films is considered.

The final results of onion drying are presented in Table 4 below [16,17].

Table 4

Device type	Drying time, day							
	0	1	2	3	4	5	6	7
	Residual mass, %							
Composite-1	100	47	21	11	10	10	9	9
Composite-2	100	56	29	15	11	10	9	9
Traditional	100	54	27	14	12	11	11	11

Қурилма тури	Қуритиш вақти, сутка						
	0	1	2	3	4	5	6
	Қолдиқ масса %						
Композит-1	100	71	37	20	10	8	8
Композит-2	100	73	40	21	12	9	9
Ананавий	100	73	40	20	11	9	9

Очиқ қуёшда	100	72	47	31	17	10	10	
1		2	3	4	5	6	7	
	Residual mass, %							
Composite-1	100	47	21	11	10	10	9	9
Composite-2	100	56	29	15	11	10	9	9
Traditional	100	54	27	14	12	11	11	11

Based on the data presented in Table 4 above, the comparative efficiency in terms of drying speed was determined.

When the residual mass for drying onions in the devices reaches 11% of the initial poured product. This value was reached in 3 days by the drying device using Composite-1 film according to Table 4. And the drying device using traditional film reached in 5 days. The observed difference in drying rate between these two devices was 67% based on expression (6). As a result, the dryer using Composite-1 achieved 67% faster drying compared to the dryer using conventional film.

According to Table 4, the drying device using composite-2 film achieved a residual mass of 11% in 4 days. As a result, the drying device using Composite-2 achieved 25% faster drying compared to the drying device using traditional film..

According to Table 4, the drying device using Composite-1 film achieved 33% faster drying compared to the drying device using Composite-2 film.

The final drying results of tomato drying are presented in Table 5 below[18].

Table 5

Device type	Drying time, day 0	1	2	3	4	5	6
	Residual mass, %						
Composite-1	100	71	37	20	10	8	8
Composite-2	100	73	40	21	12	9	9
Traditional	100	73	40	20	11	9	9
In the open sun	100	72	47	31	17	10	10

Based on the data presented in Table 5 above, the comparative efficiency in terms of drying speed has been determined.

When the residual mass during drying of tomatoes in the devices reaches 10% of the initial poured product. This value was reached in 4 days by the dryer using Composite-1 film according to Table 4. When dried in the open sun, it reached this value in 5 days. As a result, 25% faster drying was achieved in the drying device using Kompozit-1 compared to drying in the open sun.

The final drying results of carrot drying are presented in Table 5 below[19].

Table 5

Device type	Drying time, day				
	0	1	2	3	4
	Residual mass, %				
Composite-1	100	36	13	11	11
Composite-2	100	46	15	11	11
Traditional	100	37	12	11	11

Based on the data presented in Table 5 above, the comparative efficiency in terms of drying speed has been determined.

When drying carrots in devices, the residual mass reaches 11% of the initial poured product. According to Table 4, this value was reached in 3 days in all three dryers. As a result, there is no significant difference between devices.

a) onion drying is described, b) tomato drying is described, c) carrot drying is described.

Figure 2. Experimental process

The above considerations are relative efficiency determined by drying speed.

Based on this research, the following recommendations are given.

Mobile solar dryers using composite film can be used in agriculture and large-scale production. Of course, devices of this type are highly efficient, cheap to develop, easy to repair, and easy to use..

The following are the specifications of the proposed composite film for use in solar dryers.

In dryers, the product under the composite film prevents overheating of the product to be dried compared to the product under the traditional film. That is, with the help of solar radiation energy generation, only the water content of the product is brought to a suitable spectrum.

Products dried in composite film dryers have significantly higher organoleptic (appearance, smell, taste, and self-recovery) characteristics compared to products dried in traditional film dryers [20], such devices can be used to obtain high-quality dried products. It should also be noted that there is a significant positive difference in the shelf life of dried products.

Positive results were also achieved in terms of duration of work. That is, the operating period of the Composite-1 film in the solar drying device is 3-4 times longer than that of the conventional film, and Composite-2 is 6-7 times longer, it was determined based on experiments.

Composite-1 film solar dryers can be used as high drying rate devices.

During drying under composite film solar dryers, there was no formation of mold inside the drying chamber or under the film.

Conclusion. A solar drying device was developed using a composite film;

Empirical formula for determining drying dynamics in radiation drying devices and methodology of use was developed. It has been determined based on experiments that the duration of operation of Composite-1 film in a solar drying device is 3-4 times longer than that of conventional film, and that of Composite-2 film is 6-7 times longer. It was found that the drying device using Composite-1 film in drying apples achieved 40% faster drying compared to the drying device using traditional film. When drying apples, it was determined that the composite film is more effective in removing moisture from the deep layers of the product compared to the traditional film, that is, the final moisture content is 15% in the Composite-1 film dryer and 17% in the traditional film dryer. When drying grapes using Composite-1 film drying device, it was found that 44% faster drying was achieved compared to drying device using traditional film. When drying grapes, it was found that the composite film is more effective in removing moisture from the deep layers of the product compared to the traditional film, that is, the final moisture content is 21% in the Composite-1 film dryer and 24% in the traditional film dryer. When drying onions, it was found that the drying device using Composite-1 achieved 67% faster drying compared to the drying device using traditional film. When drying onions, it was determined that the drying device using Composite-2 film achieved 25% faster drying compared to the drying device using conventional film. When drying onions, it was found that the drying device using Composite-1 film achieved 33% faster drying compared to the drying device using Composite-2 film. When drying tomatoes, it was found that the drying device using Kompozit-1 achieved 25% faster drying compared to drying in the open sun.

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STRESS-STRAIN STATE OF SOIL DAMS UNDER THE ACTION OF STATIC LOADS

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Abstract:

Objective. The objective of this article is to develop a methodology for the static calculation of earth dams under the action of water pressure in the reservoir, taking into account various physical and mechanical characteristics of soils, and the design features of the Pachkamar, Gissarak, and Sokh earth dams in a two-dimensional statement.

Methods. The developed model and calculation algorithm for studying the stress and strain state of earth dams based on a variational approach using the d'Alembert principle are presented. Numerical calculations in the article are conducted using the finite element method.

Results. As a result of the study, it was revealed that the stress and strain state of the above-mentioned earth dams significantly depends on the physical and mechanical parameters of soils and the commensurability of geometric dimensions, as well as on the coefficient of slopes of the dam retaining prisms.

Conclusions. As a result of the study, it was revealed that the movement of points in the body of the dam under the action of body forces is approximately symmetrical about the vertical axis of the dam core. The largest values of displacement were observed in the core and crest zones of the dam. The level of water filling in the reservoir has a significant impact on the stress and strain state of the dam.

Keywords: earth dam, plane statement, structure, stress-strain state, variational problem.

Introduction. In earth dams, under the influence of body forces and hydrostatic water pressure (static loads), a complex interaction occurs between the parts of the structure. In some cases, under the influence of these factors, tensile stresses appear in the body of the dam and its impervious devices, which can lead to the formation of cracks in them and a violation of the strength characteristics of dams as a whole.

Research task. The stress state and deformation of earth dams is a complex problem in the theory of continuum mechanics, and it is necessary to take into account the properties of materials, the design of the structure, construction time, operation, the variety of acting loads, etc. The solution of such a problem is currently difficult due to the lack of sufficiently substantiated data on the rheological properties of soils, the difficulty of simultaneously taking into account the influence of all possible factors in the numerical implementation of the solution, etc.

At the same time, the solution of particular problems with the adoption of certain assumptions and prerequisites can be most fully and accurately obtained using numerical methods, for example, the finite element method (FEM) or the finite difference method (Красников Н.Д, 1981; Зарецкий Ю.К., Ломбардо В.Н., 1983; Мирсаидов М.М., 2010; Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023; Mirsaidov M.M., 2019).

To date, there are a number of scientific papers that are devoted to the study of the stress state and deformation of

earth dams using various models of structures.

The static stress state of various soil dams is considered in (Mirsaidov M.M., 2019; Маткаримов П., Жураев Д., Уразмухамедова З., 2022 г.; Matkarimov P.J., Juraev D.P., Usmonkhuzhaev S.I., 2022), which take into account the structures of the structure, the rheological properties of the soil, the interaction of structures with reservoir water, and other features of structures.

In (Kong X., Liu J., Zou D., 2016), the SSS of soil dams under dynamic and static effects is studied by the finite element method, taking into account the elastic-plastic deformation of the soil of the dam, and these number results are comparable to the number results of field measurements of the Wenchuan earthquake.

The paper (Alonso E.E., Cardosa R., 2010) analyzes in detail the use of non-traditional materials (earth and stone mixtures) to ensure the stability of the slopes of earth dams.

The paper (Белостоцкий А.М., Акимов П.А., Нгуен Тай Нанг Льюнг, 2017) considers a method for numerical simulation of the motion of the spatial system "Foundations - dam - reservoir" under the influence of various influences. The stress-strain states of arched concrete dams are estimated, and their natural frequencies are determined and the corresponding vibration modes are constructed. The studies used the universal program ANSYS Mechanical.

The work (Kozinetc G.L., Kozinetc P.V., 2022) provides a detailed review of the method for calculating the dynamic characteristics of structures and the results of assessing the response of structures to time-varying excitations and earthquake accelerograms. The results obtained made it possible to estimate the maximum value of horizontal accelerations.

In (Arbian A., et al., 2020), to assess the reliability of the spillway structure of the Chendero dam (Malaysia), the results of experimental spectral analysis and operational forms of deviation were used. Along with the experimental study, numerical simulation was carried out using the ANSYS software package.

In (Ravindra V., 2022), several natural frequencies of the design of the Indirasagar dam, located in the state of Andhra Pradesh, are determined taking into account only the dead weight of the dam and pressure (hydrostatic) water using the ANSYS software.

The paper (Ahmet A., 2021) presents the results of an experimental vibration study to determine the structural behavior of the Deriner arch dam. And also in the work by the numerical method (FEM) the natural frequencies and vibration modes of the dam are determined.

As the review shows, studies of the stress state and deformation of earth dams, taking into account design features and real work, have not been sufficiently studied, therefore, research in this direction is of great scientific interest. Based on the foregoing, this work is devoted to the development of a methodology for calculating the SSS of the Gissarak, Sokh and Pachkamar soil dams in Central Asia in a flat setting, taking into account the design features, material properties and the degree of filling of the reservoir. As a computing device, the finite element method is used in the work.

Methods. An earth dam of complex geometry is considered, occupying a volume $V = V_1+V_2+V_3$ (V_1, V_3 - volume of upper and lower prism, V_2 - core volume) (Fig. 1). Dam foundations Σ_u are rigidly clamped, and the surface of the lower slope and ridge are free from stress. The dam is under its own weight $\vec{f}$ and to the surface Σ_1 water pressure (hydrostatic) $\vec{p}$.

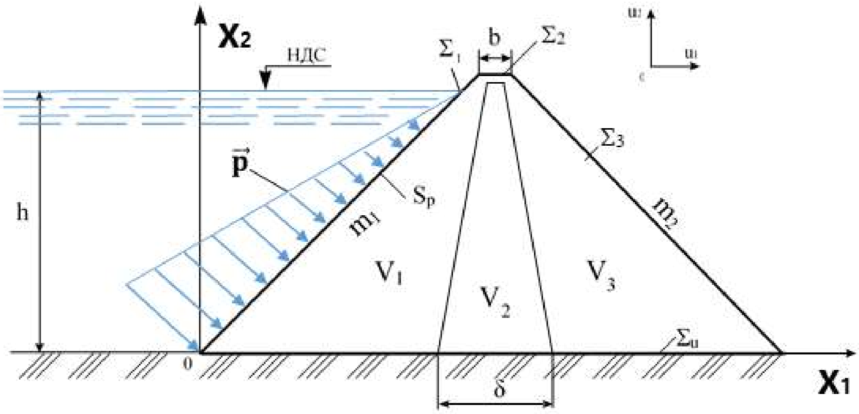


Figure. 1. Calculation scheme of an earth dam

To solve the given problem, we used the principle of possible displacements. According to this principle, the sum of all acting active forces is zero (Мирсаидов М.М., 2010; Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023; Mirsaidov M.M., 2019; Маткаримов П., Жураев Д., Уразмухамедова З., 2022 г.; Matkarimov P.J., Juraev D.P., Usmonkhuzhaev S.I., 2022):

$$\delta A = -\int_{V_1} \sigma_{ij} \cdot \delta\varepsilon_{ij} dV - \int_{V_2} \sigma_{ij} \cdot \delta\varepsilon_{ij} dV - \int_{V_3} \sigma_{ij} \cdot \delta\varepsilon_{ij} dV + \\ + \int_V \vec{f} \cdot \delta\vec{u}\, dV + \int_{\Sigma_1} \vec{\mathrm{p}} \cdot \delta\vec{u}\, d\Sigma = 0, \quad i, j = 1,2 \tag{1}$$

The physical properties of the body are described by the Hooke relations (Александров А.В., Потапов В.Д., 1990),

$$\left.\begin{aligned} \sigma_{11} &= \lambda\theta + 2\mu\varepsilon_{11} \\ \sigma_{22} &= \lambda\theta + 2\mu\varepsilon_{22} \\ \sigma_{12} &= \mu\varepsilon_{12}. \end{aligned}\right\} \tag{2}$$

$$\lambda = \frac{E\nu}{(1+\nu)(1-2\nu)}, \quad \mu = \frac{E}{2(1+\nu)}.$$

and Cauchy relations

$$\varepsilon_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right), \tag{3}$$

as well as the boundary condition

$$\vec{x} \in \sum u: \quad \vec{u} = 0 \tag{4}$$

In calculations, the value of hydrostatic water pressure on the upper slope of the dam is determined by the formula

$$p = \rho_0 g(h - x_2) \tag{5}$$

Here $\vec{u}$, σ_{ij}, ε_{ij}, - displacement vectors, stress and strain tensors; ρ - density of material; ρ_o - density of water, (h –x_2) – reservoir filling level (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

To solve the variational problem (1) - (3) for a region of a non-canonical complex shape, the most convenient is the finite element method (FEM), which allows taking into account both the geometry features and the properties of the construction material. Here, the area occupied by the body is divided into sub-areas with different physical and mechanical characteristics, then the sub-areas are automatically divided into triangular finite elements of the first order with 6 degrees of freedom. As a result, a discrete continuum model is created.

Using a feature of the finite element method allows us to reduce the considered variational problem (1)-(4) to a system of non-homogeneous high-order algebraic equations, i.e.:

$$[K]\{u\} = \{P\} \tag{6}$$

Here: $[K]$ - stiffness matrix for the considered body (Fig. 1); $\{P\}$ - components of external forces acting on the nodes of the finite element; $\{u\}$ - the desired components of the displacement vectors in the nodes of the finite element (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

When solving the above tasks, we used the calculation program developed by us on a PC. In this case, the number of unknowns in equations (6) reached 6200.

Results and Discussion. The paper investigates the stress-strain state of soil dams in a two-dimensional setting, under the action of hydrostatic water pressure and its own weight. In calculations of the effect of water on the stress-strain state of dams, the gradual filling of the reservoir was considered.

With the help of the above mathematical model and method, the SSS and the strength of these dams under water in the course of the river, self-weight of the structure are studied, the design features of the dams in question and acceptance account the mechanical and physical characteristics of soils.

The research work was carried out in erath dams located in the territory of Uzbekistan. Information about these earth am is given below:

1) Gissarak dam high H=138.5 m was built in the Kashkadarya region of Uzbekistan, with slope coefficients of earth dam m_h=2.2, m_m=1.9. Prisms are established from the rock mass. Physical and mechanical parameters of soil - E=3600 MPa, specifical gravity - γ=1.9 kF/m^3, Poisson's ratio - ν=0.3. Core is established from loam. Physical and mechanical parameters of loam - E=2400 MPa, soil specific gravity - γ=1.7 тс/м^3, Poisson's ratio - ν=0.35 and adhesion coefficient C= 20 kPa. Transition zone of sandy-gravelly soil. Dam crest with width b=16m and length L=660m; (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

2) Sokh dam high H=87.3 m is located in the Fergana region, slope coefficients are m_b=2.5, m_H=2.2. Both prisms - from pebbles with physical and mechanical parameters - E=3550 MPa, Poisson's ratio - v=0.35 and specifical gravity - γ=2.1 kF/m^3. The core is established from loam. Mechanical and physical parameters of loam soil - E=2400 MPa, Poisson's ratio - v=0.35, specific gravity of the soil - γ =1.75 kF/m^3 and Dam crest with width b=10 m and length L=487.3; (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

3) **Pachkamarskaya dam high** H=70 m was built in Kashkadarya region, with slope coefficients m_b=m_H=2.25. Thrust prisms - from pebbles and sand with mechanical and physical parameters - E=3600 MPa, soil specific gravity - γ=2.25 kF/m^3, Poisson's ratio - v=0.3. The core is

established from loam with physical and mechanical parameters - E=2400 MPa, specific gravity - γ=1.78 kF/m^3, Poisson's ratio - ν=0.35. (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

The results of numerical studies are the components of displacement vectors u, v, deformations ε_x, ε_y, γ_{xy} and stresses σ_x, σ_y, τ_{xy} for all points of construction. Below is the construction of isolines of the displacement components and stresses in the cross sections of the dam.

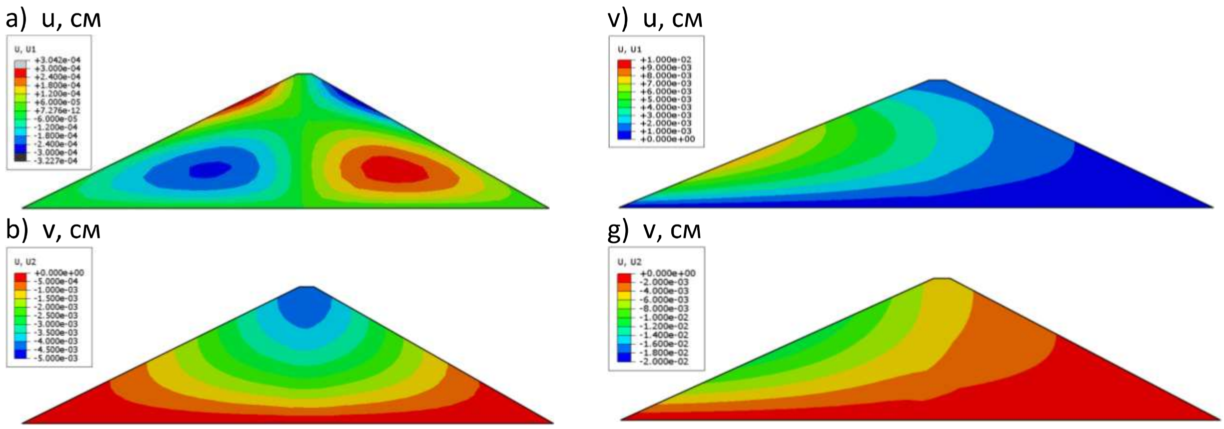
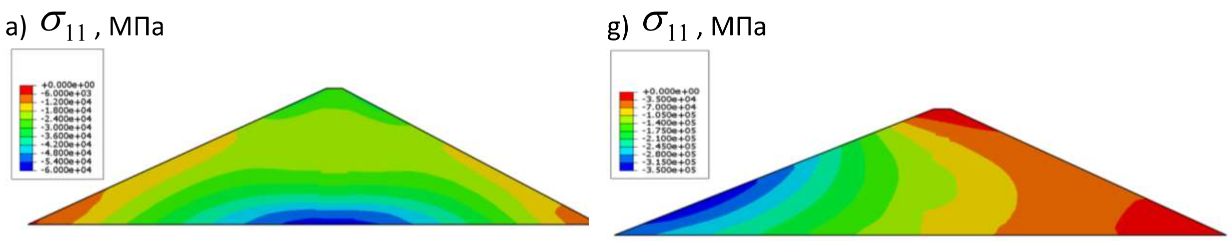


Fig. 2. Field of equal levels of displacements (u and v) of the Hissarak dam with empty (a, b) and full filling of the reservoir (c, d)

The analysis of the obtained results (Fig. 2 a and b) shows that the value of displacements in the body of the dam has an approximately symmetrical character with respect to the vertical axis of the dam. In the center of the dam, horizontal displacements are equal to zero, and their value increases towards the upper and lower prisms. This is explained by the rapid implementation of calculations taking into account the dam's own weight. The displacement at the upper points of the dam is greater than at the lower points (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

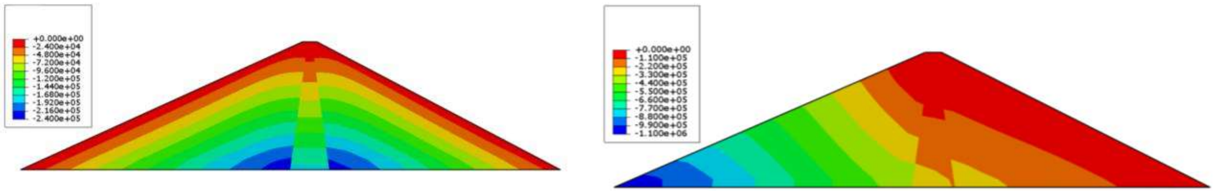
The values of the displacements in the Gissarak dam (Fig. 2. c and d)depend on the level of water affecting the dam. Similar results were found in the study of the stress-strain state of the Pachkamar and Sokh dams (Mirsaidov M.M., Vatin N., Sultanov T.Z. and Juraev D.P, 2023).

Figure 3 shows lines of equal levels of horizontal σ_{11} (a), vertical σ_{22} (б) and tangents σ_{12} stresses of the Gissarak dam under the action of body forces and pressure (hydrostatic) of water at empty and full filling of the reservoir.



b) σ_{22}, МПа

d) σ_{22}, МПа



v) σ_{12} , МПа   e) σ_{12} , МПа

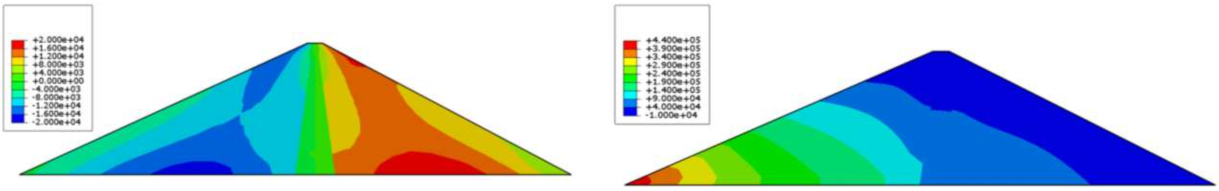


Figure 3. Field of equal horizontal levels σ_{11} (a, g), vertical σ_{22} (b, d) and tangents σ_{12} (b, e) Stresses for the Hissarak Dam
at empty (a, b, c) and full (d, e, f) filling of the reservoir

The obtained results show that in areas close to the contour, the stresses of the dam are practically zero, which is explained by the absence of load on the surface of the crest and slopes. The SSS as a whole is almost symmetrical about the vertical axis of the dam. And lines of zero level of tangential stresses - σ_{12} pass along the central axis of symmetry of the dam. With distance from this axis, σ_{12} increase, reaching a maximum at the bottom of the slopes. At the same time, the influence of the design features of the core leads to the appearance of an arch effect and a significant change in the SSS of the dam. The above phenomena are explained by the fact that due to differences in the deformability of the materials of the loamy core, thrust prisms and the transition zone of the dam. As a result of this type of deformation, the solidity of the dam can be broken with the probable formation of through transverse cracks inside and longitudinal cracks on the crest of the core (Тейтельбаум А.И., Мельник В.Г., Саввина В.А., 1975).

A comparison of the obtained results shows that when the reservoir is completely filled, the influence of the hydrostatic water pressure completely changes the nature of the stress distribution σ_{11}, σ_{22} And σ_{12} in the body of the dam and their symmetrical character is completely lost. In this case, the value of stresses σ_{11} increases by 1.5-2 times, and the value of vertical stresses σ_{22} increases up to 1.5 times in areas close to the slope of the upper prism.

Conclusions.

1. A mathematical model based on the variational Lagrange equation has been developed to calculate the stress-strain state of soil dams in a two-dimensional formulation. With the use of the numerical method (FEM), the problem posed was reduced to a high order nonhomogeneous algebraic problem.

2. Using the developed algorithm and calculation program, the SSS of dams made of soils under the action of body forces and pressure (hydrostatic) of water was studied.

3. It was revealed that:

- displacements of the dam under the action of body forces are approximately symmetrical with respect to the vertical axis of the dam core. At points located in the upper levels of the structure, the displacement values are greater than at the points of the lower level. On the crest and the zone of the core of the dam, the highest displacement values are observed;

- when studying the stress-strain state of dams made of soils, it is necessary to take into account design features, i.e. the deformable properties of the core, since this significantly affects the prediction of the

stress-strain state of the structure and makes it possible to assess its strength;

- the level of water filling in the reservoir has a significant impact on the stress-strain state of the dam body, while the maximum effect is observed when the reservoir is completely filled.

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UDC: 004.4; 621.315.1

MICROCONTROLLER-BASED REMOTE MONITORING OF OVERHEAD POWER LINES

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Abctract:

Objective. Due to the technical failure of the line, illegal connections, temperature rise in the cable occurring in the section between the electricity distribution point and the consumer meter of the overhead power lines, a number of difficulties arise in monitoring the energy consumption in the line. There are a number of ways to solve these problems, among which remote monitoring using modern IoT wireless sensors and microcontroller control devices gives effective results. Because this method is the basis of the SG (smart grid), which is widely used in the future. The main goal of this article is to design a monitoring device used in remote monitoring of the condition of low-voltage overhead power lines, classify the structure and characteristics of the sensors used in it, and do a comparative analysis of the modules used in the construction of the data transmission network.

Methods. It is not possible to adequately monitor the condition of 0.4-6 kV transmission lines using ASCAE (automated system for control and accounting electricity). These methods can calculate the amount of energy coming out of the distribution transformer and the amount of power passed through the consumer meter. Therefore, this paper proposed a remote monitoring method based on microcontroller control for real-time monitoring of the status of low-voltage overhead power lines.

Results. As a result of the research, a remote monitoring device was designed, capable of transmitting the results obtained from voltage, current and temperature sensors in real time from two wireless transmission modules. This device transmits data to the concentrator using ZigBee, and it transmits data to the monitoring center through the GSM module. In addition, the microcontroller control unit in the device takes into account the geographic location of the object and the synchronized time.

Conclusion. The system, which is organized using a remote monitoring device, prevents technical failures that may occur in low-voltage overhead power transmission lines, the current parameters of the line (voltage, current, cable temperature, wind speed, phase) and unexpected to the line (the unregistered-illegal connection) provides opportunities to send real-time information about downloads.

Keywords: energy, wireless sensors, voltage, current, temperature, ZigBee, ESP32, IoT, smart grid, power, monitoring system.

Introduction. Application of modern methods of corporate management, advanced information and communication technologies and automated systems of management, accounting and control into the energy sector, on this basis, increase management efficiency and reduce production costs plays an important role in ensuring the transparency of energy sector organizations and financial activities. Especially in recent times, special attention has been paid to studies aimed at regular monitoring of the condition (freezing of the cable, disconnection, temperature rise,

erosion of elements in the line and failure due to external influences) of overhead power transmission lines for transmitting electricity over long distances without losses [1].

Monitoring of energy losses is very important for energy distribution and energy supply companies to achieve economic efficiency. Because the grid length of low-voltage (0.4-6kV) overhead power lines is much larger than other power lines. In addition, the impossibility of real-time remote monitoring of this network (between the distribution station and the consumer meter) requires scientific and practical research in this area. The concept of smart grid (SG) plays a key role in this. The essence of SG is real-time monitoring of the entire energy network with the help of modern IT technologies based on centralized management. The main constituent elements of SG are: internet of things (IoT), sensors, radio modules, web applications and microcontroller control devices [2, 3]. In this article, as an element of the SG concept, a device for remote monitoring of the condition of low-voltage overhead power lines, its structural structure, characteristics and communication tools was given detailed information [4].

The following tasks were defined for remote monitoring of the condition of overhead power lines:

–*sensor selection:* suitable sensors are selected (taking into account the location and availability of the power grid) to measure the monitored parameters, such as voltage, current, power factor and frequency;

–*communication network analysis:* communication network that can transmit data from sensors to the monitoring center is selected for analysis. This can be done using wired or wireless networks, depending on the location and accessibility of the power grid;

–*data analysis:* data analysis tools are used to analyze data collected from sensors and detect any unexpected situation or problems in the power grid;

–*detection of errors and illegal connections:* algorithms are developed to detect situations such as short circuits, overloads and faults in the neutral. This can be done using a combination of sensor data and machine learning algorithms;

–*alerting and reporting:* a system will be implemented to alert and report any problems detected by the monitoring device. This includes sending alerts to maintenance staff or generating reports for management;

Methods. Electricity is mainly produced in large power plants that are connected to a single energy system and work together. And the centers of electricity consumers (industrial enterprises, cities, rural settlements, agro-industrial complexes and other consumers) are located at a distance of hundreds or thousands of kilometers from sources of electricity. The following figure shows the elements of the power transmission and distribution system (Figure 1).

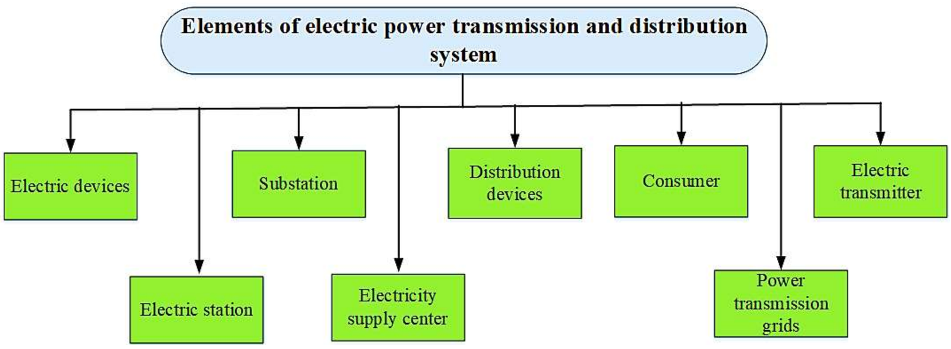


Figure 1. General elements of the electric power transmission and distribution system

In total, there are more than 240,000 km of power transmission lines in our republic, of which:

• 500 kV networks - more than 2000 km
• 220 kV networks - more than 5300 km
• 110 kV networks - more than 5600 km
• 35 kV networks - more than 12100 km
• 6-10 kV networks - more than 97100 km;
• 0.4 kV networks - 112370 km [4, 5].

The main cases observed recently in Overhead Power Lines (OPL) are: technical failure and illegal connections to the line. In some cases, the network is shut down by the monitoring center during line maintenance and necessary measures are taken. In this case, the level of energy loss does not exceed the permissible amount. However, in some cases, it is possible to observe energy loss in the line due to several factors, for example, illegal use of energy. Illegal use of electricity is considered to have occurred in the following cases: when it is carried out without a consumption contract, when the metering equipment is bypassed, or when the meter is changed to change the indicators; the main goal is to save money [6].

Results. A remote monitoring device and model were developed to overcome the mentioned situations (Fig. 2). This model consists of three parts, each part performs separate functional tasks [7].

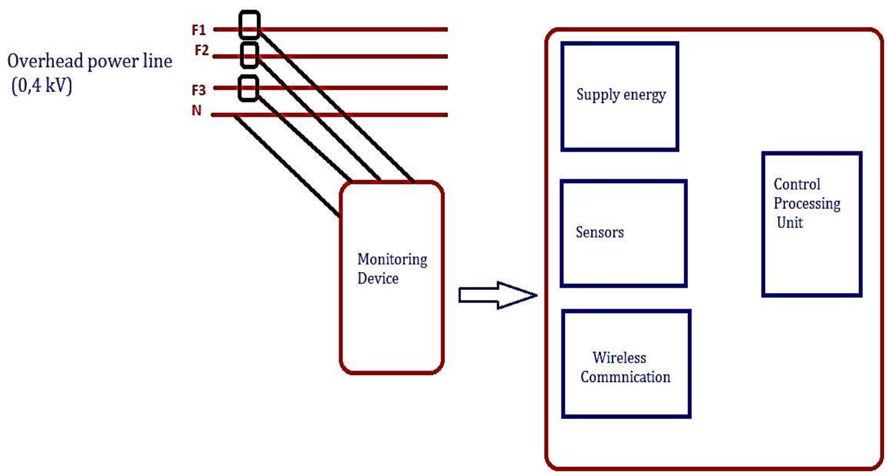


Figure 2. Remote monitoring system model

According to this model, each phase of 0.4 kV lines is connected by a monitoring device. Sensors measuring voltage, current, temperature and frequency in the monitoring device calculate the current state of the phases. The received information about the condition through the control unit of the model is sent to the monitoring center using a radio module. In the selection of the used sensors, special attention was paid to the condition of the line, its characteristics, and the reliability indicators of the sensors [8].

There are many supports in the low voltage overhead power grid. In the proposed model, it is assumed that each electric support will be equipped with a monitoring device. Such a monitoring device is equipped with built-in sensors and a microcontroller to monitor the condition of the power line, analyze the power quality, and control the use of electricity.

ESP (Espressif Systems*) 32 SIM7000G module.* In order to further develop IoT and expand its field of application, robust, low-cost and low-power

solutions for IoT devices are required. Another requirement for an IoT device is to have a small form-factor; the smaller the size and weight of the device, the wider its field of application [9].

Every IoT device is made up of a microcontroller (µC) and a wireless transferring module (typically WiFi), or a combination of both. Many various kinds of modules and µC are already accessible through the market and are widely used in the construction and creation of IoT devices.

These include Xbee, WhizFi, and various Arduino boards. However, the majority of current devices are either too expensive or too large in terms of weight and dimensions. Furthermore, a very small number of modules are open-source devices with no performance constraints. Espressif Systems released the ESP32 QFN48 chip in September of 2016, replacing the older ESP8266 µC.

The ESP32 is a sophisticated microcontroller with Wi-Fi and Bluetooth® that has been constructed to be the best choice for IoT devices [10]. This module is the primary control module of the proposed monitoring device, and it is utilized for protecting the device's connection with the sensors, and it also serves to receive and monitor data from the sensors. The ESP32 is a low-cost, low-power system-on-chip microcontroller series with a highly integrated structure powered by a dual-core Tensilica Xtensa LX6 microprocessor. This module also includes LTE (4G), GPS and GPRS elements. With this module, it is possible to receive SMS service, location and time using GPS, Internet connection using SIM card data plan (a data plan refers to a data quota in a telecommunications or data hosting contract) [11, 12].

Table 1.

Classification of microcontrollers for designing IoT devices [13]

Chip (module)	ESP32 (ESP–WROOM-32)	ESP8266 (ESP8266-12E)	CC32 (CC3220MODSF)	Xbee (XB2B-WFPS-001)
Details				
CPU	Tensilica Xtensa LX6 32 bit Dual-Core at 160/240 MHz	Tensilica LX106 32 bit at 80 MHz (up to 160 MHz)	ARM Cortex-M4 at 80 MHz	N/A
SRAM	520 KB	36 KB available	256 KB	N/A
FLASH	2MB (max. 64MB)	4MB (max. 16MB)	1MB (max. 32MB)	N/A
Voltage	2.2V to 3.6V	3.0V to 3.6V	2.3V to 3.6V	3.14V to 3.46V
Operating	Current 80 mA average	80 mA average	N/A	N/A
Programmable	Free (C, C++, Lua, etc.)	Free (C, C++, Lua, etc.)	C (SimpleLink SDK)	AT and API commands
Open source	Yes	No	No	No
Connectivity				
Wi-Fi	802.11 b/g/n	802.11 b/g/n	802.11 b/g/n	802.11 b/g/n
Bluetooth®	4.2 BR/EDR + BLE	-	-	-

UART	3	2	2	1
I/O:				
GPIO	32	17	21	10
SPI	4	2	1	1
I2C	2	1	1	-
PWM	8	-	6	-
ADC	18 (12-bit)	1 (10-bit)	4 (12-bit)	4 (12-bit)
DAC	2 (8-bit)	-	-	-
Size	25.5 x 18.0 x 2.8 mm	24.0 x 16.0 x 3.0 mm	20.5 x 17.5 x 2.5 mm	24.0 x 22.0 x 3.0 mm
Price	114,529 sum	71,542 sum	228,936 sum	329,183sum

The table below contains information about the four modules and C used to create IoT devices. Actually, there is a wide range of elements and microcontrollers for IoT, but the majority of them have issues with size, performance, and cost. In comparison to other microcontrollers, the ESP32 QFN48 is an extremely small element, measuring only 5x5mm. For more sophisticated tasks, the ESP32 is a better choice [14].

Voltage sensor. A ZMPT101V sensor manufactured by Qingxian Zeming Langxi Electronic was used to measure the line current voltage. When using this sensor, an additional resistance element is not required in the connection of contacts.

Table 2.

Technical characteristics of the voltage sensor

Voltage area , V	Insulation voltage,V	Current , mA	Supply voltage, V	Power indicator	Size, mm	Weight, gramm
0 - 1000	4000	2	4÷12	LED	50 x 19 x 23	25

Current sensor. The SCT024TS-D sensor was used to measure the line current. This sensor has a silicone coating, easy to install, it can measure the current value of AC lines with a frequency of 50Hz-1000Hz, a voltage of up to 720V, a range of 100A-300A . This device is highly durable and does not lose its ability to work at temperatures up to -25 ^{0}C~60^{0}C.

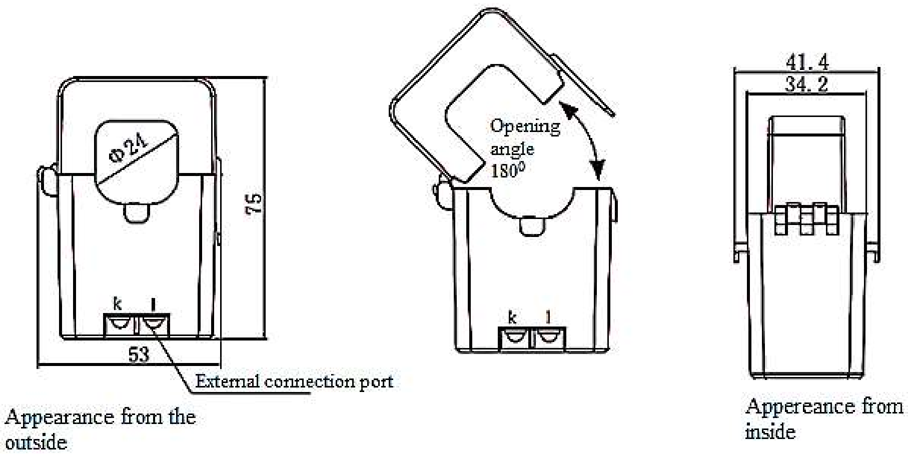


Figure 3. Schematic diagram of the current sensor

According to the proposed model, voltage and current sensors (IoT sensors) monitor the secondary current, voltage and load current of the distribution transformer. The entire power sent from the distribution transformer is monitored by an energy sensor. In the system, backup of communication channels is carried out, which implies the transmission of data bypassing the defective device not only within one phase wire, but also through devices on neighboring phase wires. The data collection module can be replaced by another depending on the monitoring tasks [15].

Discussions. Data received from modular devices are collected in the permanent and additional memory of the concentrator. The collected data is sent to the monitoring brand using radio transmission modules and displayed on the computer of the monitoring center through the web interface. The large number of bases in data transmission can cause problems and prevent information from being received at the right time. Therefore, *ZigBee* module is used to act as a repeater. Since the ZigBee module consumes little power, it can work for several months even on a normal battery. Below is the circuit diagram of ZigBee module and ESP32 SIM700 microcontroller [16].

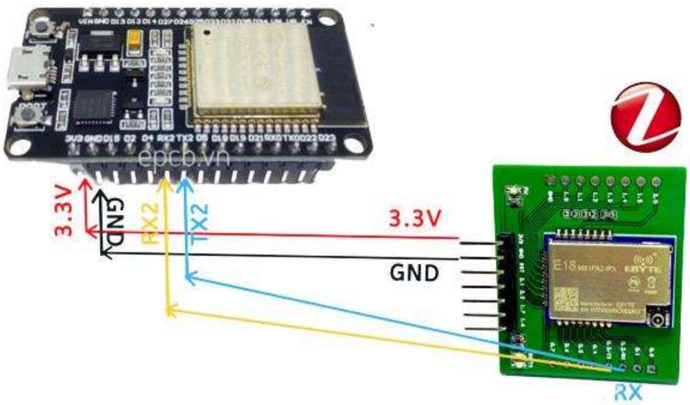


Figure 4. ZigBee module and ESP 32 SIM700 connection diagram

According to quality of service (QoS) indicators, ZigBee modules can be divided into 2 types: external (used in an open facility) and internal (used indoors). The following ZigBee modules were compared in terms of packet delivery ratio (PDR), current and energy consumption, network lifetime, delay and throughput [17].

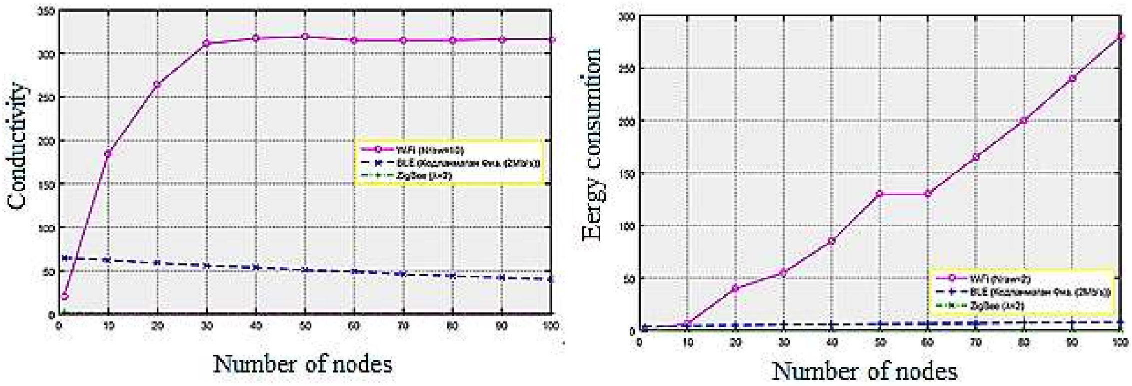
Table 3.

Technical specifications of popular ZigBee modules [18]

ZigBee Module	Transmitter	Programmable memory	Programmable CPU Clock	Number of chanels	Receiver sensitivity	Tx power	Current Tx and Rx
XBee S2C	Silicon Labs EM357 SoC	32 KB Flash/ 2 KB RAM	Up to 50.33 MHz	16	−100 dBm/ −102 dBm (boost mode)	3.1 mW (+5 dBm)/ 6.3 mW (+8 dBm) boost mode	Tx: 33 mA @ 3.3 VDC/ 45 mA boost mode Rx: 28 mA @ 3.3 VDC/ 31 mA boost mode

XBee-Pro S2C	Silicon Labs EM357 SoC	32 KB Flash/ 2 KB RAM	Up to 50.33 MHz	15	−101 dBm	63 mW (+18 dBm)	Tx: 120 mA @ 3.3 VDC Rx: 31 mA @ 3.3 VDC
XBee S2D	Silicon Labs EM3587 Soc	N/A	N/A	15	−100 dBm/ −102 dBm (boost mode)	3.1 mW (+5 dBm)/ 6.3 mW (+8 dBm) boost mode	Tx: 33 mA @ 3.3 VDC/ 45 mA boost mode Rx: 28 mA @ 3.3 VDC/ 31 mA boost mode
XBee 3	Silicon Labs EFR32MG SoC	1 MB/128 KB RAM	-	16	−103 dBm normal mode	+8 dBm	Tx: 40 mA @ 8 dBm Rx: 17 mA
XBee 3 Pro	Silicon Labs EFR32MG SoC	1 MB/128 KB RAM	-	16	−103 dBm normal mode	+19 dBm	Tx: 135 mA @ 19 dBm Rx: 17 mA

ZigBee is also a wireless network technology based on the IEEE 802.15.4 specification, which includes a set of high-level communication protocols. This technology, called ZigBee, is designed to be simpler and cheaper than other wireless personal networks, such as Bluetooth or Wi-Fi. When choosing network technologies, special attention is paid to their transmission capacity and energy efficiency [19-20].



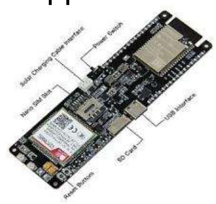
a) b)

Figure 5. Graphs comparing WiFi, Bluetooth, and ZigBee wireless network standards in terms of throughput (a) and energy efficiency (b)

In general, the appearance and characteristics of the main components of the monitoring device are detailed in the table below.

Table 4

Device elements

T/r	Name of element	Appearance
1	LILYGO TTGO T-SIM7000G Module ESP32-WROVER-B	

2	DS1820 Stainless Steel Package Waterproof DS18b20 Temperature Black Probe Temperature Sensor 18B20 Fit For Arduino	
3	ZMPT101B Active Single Phase Voltage	
4	Split Core Current Transformer SCT024TS-D Rated Input 100A, 150A, 200A, 250A, 300A Output 1V/3V/5V DC 50-60HZ 2%	
5	CC2592 PA ZigBee module 16 Mb RM yadro 2,4 GHz	

Conclusion. Remote monitoring of low-voltage (0.4 kV) OPL situations uses sensors that are suitable for the specific environment and conditions of the transmission line, if the temperature in the transmission line is too high, then the sensor we choose must withstand these temperatures. In addition, taking into account the power consumption of the device, low-power sensors, an Arduino board and a ZigBee module were selected. To minimize power consumption and increase device battery life, a wireless protocol specially designed for low-power devices such as ZigBee is used.

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DESIGN OF A RESOURCE-EFFICIENT CHAIN DRIVE STRUCTURE FOR THE DEVICE DRIVE THAT DISTRIBUTES THE SEED IN THE BUNKER TO THE LINTERS

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Annotation. In the article, a new chain drive structure with elastic elements is designed for the seed distribution device drive. At the same time, the parameters of the proposed chain drive are defined.

Keywords. Chain, driver sprocket, driven sprocket, roller, bushing, elastic element, number of teeth, gear ratio, step, coefficient, drive.

Introduction. The creation of new types of resource-saving, high-efficiency transmissions and their continuous improvement are gaining urgent importance in the world for technological machinery drives. One of the important tasks is the development of chain transmissions that can work effectively in various technological processes, suppress noise and vibrations, and create methods for their calculation. Therefore, a lot of attention is being paid to the widespread use of chain mechanisms with elastic elements with low energy consumption and high productivity in the drives of various technological machines. The rapid development of mechanical engineering requires conducting scientific research aimed at creating resource-efficient types of chain drives with wide kinematic and dynamic capabilities. In this direction, especially in order to reduce friction, wear, noise and vibration in chain mechanisms, including the creation of constructions of chain drives with belt elements that adapt to the technological process used in the operation of cotton ginning machines, the development of substantiation and calculation methods of their technological work process. Conducting research is urgent. In our republic, special attention is paid to the rapid development of mechanical engineering, the creation of new types of resource-efficient machine and mechanism structures.

The main part. It is known from mechanical sciences that the set of mechanisms that adjust the necessary power and speed of movement from the source of mechanical energy to the working part of the machine is called the drive of the machine. However, if the shaft of the working part of the machine is directly connected with the shaft of the electric motor (for example, a fan, compressor, etc.), then the electric motor itself is considered as the driving mechanism of the machine. However, in addition to electric motors, car drives include various mechanical drives with several steps. The simplest such driving shafts are composed of a reducer and an electric motor connected by a mutual coupling. However, in most cases, there are various types of transmissions, except for the nodes indicated in the structure of the procedures used. It depends on the type of machines, the required movement speed and power of its working part. Today, every person with an engineering profession should have the ability to design transmissions in technological machinery drives. In such cases, the most important issue is the correct selection, placement and calculation of sprockets in the structure. A structural design was carried out for the

drum drive that distributes the compound roller chain drive to the linters in the hopper. The kinematic scheme of the drum that distributes the seed in the bunker to the linters is presented in Fig. 1.

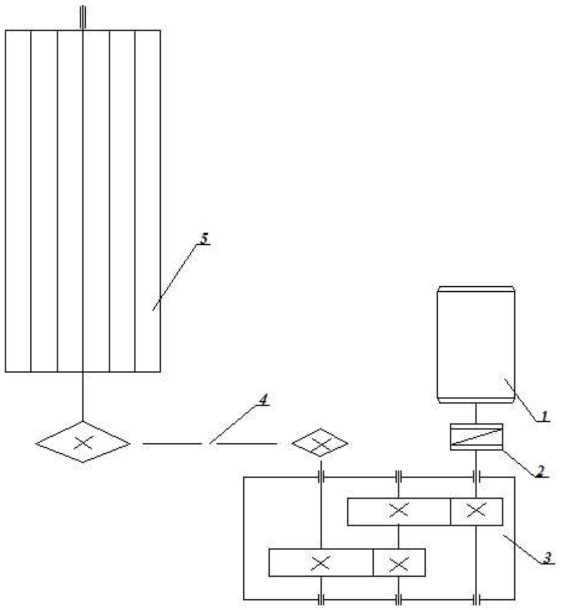

Figure 1. Kinematic scheme of the device that distributes the seed in the bunker to the linters

1-electric motor, 2-coupling, 3- two-stage cylindrical gear reducer, 4-chain drive, 5-seed distribution device

It is recommended to have a roller chain transmission with the content shown in Figure 2 as a chain drive of the machine shown in Figure 1, taking into account the loading characteristics. The proposed chain transmission works in the following order [1]: the drive from the leading sprocket 1 to the driven sprocket 2 is transmitted through the chain 3. Then, the drive sprocket 2 is transmitted to the output shaft 7 through the elastic bushing 5 and base 6. It is observed that the frictional force and other harmful forces generated between the chain 3 and the sprocket 2 are somewhat reduced when passing through the elastic element 5. When the chain 3 interacts with the driver 1 and the driven 2 sprokets, the feed of the bushing 13 and the sprocket is reduced due to the deformation of the elastic element 15 in the chain roller 12.

Due to the deformation of the elastic element 15, the friction between the bushing 11 and the roller 10 also decreases. This leads to an increase in the durability of the chain drive elements. During operation, it is recommended that the surface 16 of the rubber bushing 15 be concave in order to center the pressure forces acting on the roller 12 from the driver 1 and driven 2 sprockets. The elastic element in the roller 12 ensures even distribution of external pressure forces. This causes the service life of the chain to increase [2-7].

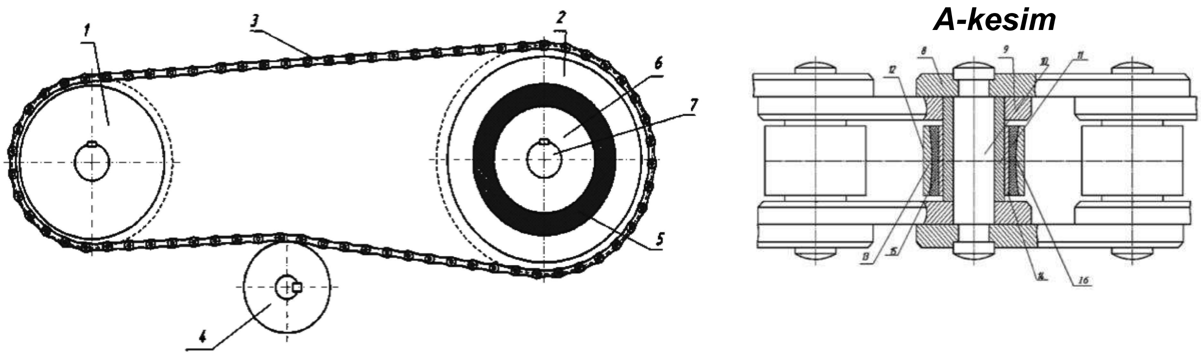

Figure 2. Containing roller chain drive

The values obtained from the calculation of the kinematic and dynamic parameters of the drive to calculate the chain drive are given below:

electric motor power: $N = 11kW$*; number of revolution per minute* $n_e = 1458\ rpm$*;*

the number of revolutions of the drive shaft of the chain drive: $n_1 = 72\ rpm$*;*

gear ratio of the chain drive: $u_z = 4$*;*

gear ratio of two-stage cylindrical gear reducer $u_r = 20{,}1$*.*

Based on the available parameters, we calculate the structural parameters of the chain drive of the device drive that distributes the seed in the bunker to the linters:

1. The number of teeth of the driver sprocket:

$$Z_1 = 31 - 2u_z \tag{1.1}$$

where, u_z – is the gear ratio of the chain drive.

Then, according to expression (1.1), the number of teeth of the driver sproket of the chain drive:

$$Z_1 = 31 - 2 \cdot 4 = 23.$$

2. The number of teeth of the driven sprocket is determined by the following expression:

$$Z_2 = Z_1 \cdot u_Z, \tag{1.2}$$

then the number of teeth of the chain drive sprocket is as follows:

$$Z_2 = 23 \cdot 4 = 92.$$

3. The step of the chain is determined by the following expression;

$$t \geq 2{,}8 \cdot \sqrt[3]{\frac{T_1 \cdot k_e}{Z_1 \cdot [P] \cdot m}} \tag{1.3}$$

where: T_1 – is the torque [N·mm] on the driver sprocket shaft, we determine it by the following expression

$$T_1 = T_d \cdot u_r \cdot \eta_r, \tag{1.4}$$

where: T_d – is the value of torque on the motor shaft, it is determined as follows:

$$T_d = \frac{N_{el}}{\omega_d} = \frac{11 \cdot 10^3 Vt}{\frac{\pi \cdot n_{el}}{30}} = \frac{11\ 000\ Vt}{152{,}6\ rad/sek} = 72\ N \cdot m = 72 \cdot 10^3 N \cdot mm,,$$

given in this expression ω_d – represents the angular velocity value of the motor shaft.

η_r –is the useful work coefficient of the two–stage cylindrical reducer, its value according to available data is $\eta_r = 0{,}84$.

Then the value of the torque on the drive shaft of the chain drive according to the expression (1.4) is equal to the value of the torque on the drive shaft of the chain drive:

$$T_1 = T_d \cdot u_r \cdot \eta_r = 72 \cdot 10^3 N \cdot mm \cdot 0{,}84 \cdot 20{,}1 = 1215{,}648 \cdot 10^3\ N \cdot mm.$$

K_e– is the coefficient of operation, [P] is the permissible value of the pressure acting on the chain joint, which is obtained based on the available tables, for the chain

transmission joint of the technological machine that we are considering, $n_1 = 72$ rpm when [P]=20MPa is appropriate. In the case of m-chain row, it is single-row, but taking into account that it breaks quickly during the work process, we get the value of $m = 2$, i.e. double-row chain.

The coefficient of operation k_e – is a coefficient that takes into account all external factors in the introduction of chain transmission, its value is determined by the following empirical expression:

$$k_e = k_1 \cdot k_2 \cdot k_3 \cdot k_4 \cdot k_5 \cdot k_6 \cdot k_7 \qquad (1.5)$$

k_1 – is a coefficient that takes into account the nature of the change in the value of the load on the drive shaft of the chain drive, taking into account the normality of the load of the working bodies of the drum that distributes the seed in the bunker to the linters, it is appropriate to take $k_1 = 1$;

k_2 – is a coefficient that takes into account the distance between the shafts of the driver and driven sprockets of the chain drive (interaxial distance), and it is advisable to take its value $k_2 = 1{,}15$ in accordance with the existing transmission location scheme;

k_3 – is the coefficient that takes into account the value of the angle θ between the direction of the line connecting the centers of the stars of the chain drive and the horizontal plane, taking into account the value of $\theta < 60^0$ for the case we are looking at and taking into account the presence of a tensioning device from time to time, the valuee $k_3 = 1{,}1$, it is desirable;

k_4 – is a coefficient that takes into account the method of adjusting the tension of the chain drive chain, $k_4 = 1.23$ was adopted, taking into account that the tension of the chain transmission is adjusted from time to time;

k_5 – is a coefficient that takes into account the lubrication method, and since the details of the chain drive are periodically lubricated in the dusty environment of vegetable oil production enterprises, we can get the value of $k_5 = 1{,}35$;

k_6 – is the coefficient taking into account the working mode, so $k_6 = 1{,}26$ was accepted because the work is organized in two shifts on average in accordance with the seasonal production values of the researched enterprise.

k_7 – it is a coefficient that takes into account the presence of a elastic element in the chain transmission roller, and it is desirable to take, $k_7 = 0.92$. It should be noted that the element of the roller elastic with the content significantly reduces the value of the external load and leads to a decrease in the value of the negative impact on other parts of the transmission.

According to the expression (1.5), the value of the exploitation coefficient k_e is as follows:

$$k_e = 1 \cdot 1{,}15 \cdot 1{,}1 \cdot 1{,}23 \cdot 1{,}35 \cdot 1{,}26 \cdot 0{,}92 = 2{,}435.$$

Based on the obtained results, it is possible to determine the pitch of the chain drive being designed by the expression (1.3):

$$t \geq 2{,}8 \cdot \sqrt[3]{\frac{1215{,}648 \cdot 10^3\ N \cdot mm \cdot 2{,}435}{23 \cdot 20 \cdot 2}} = 2{,}8 \cdot 14{,}76 = 41{,}33mm.$$

Based on the result, we choose the type of chain with the following parameters standardized by GOST:

- *Designation– 2R-44.45-344;*
- *28A-2 according to ISO 606;*
- *step t=44,45 mm;*
- *roller diameter $d_1 = 25{,}4\ mm$;*

- *internal plate spacing width* $b_{1min} = 25{,}4\ mm$;;
- *roller diameter* $d_2 = 12{,}7mm$;
- *roller length* $b_{7max} = 110\ mm$;
- *inner plate width* $h_{max} = 42{,}4\ mm$;
- *transverse step* $A = 48{,}87\ mm$;
- *roller support surface* $A_{tay} = 946\ mm^2$;
- *chain breaking load* $Q_{min} = 344{,}8\ kN$;
- *the weight of one meter of chain* $q = 14{,}4\ kg$.

According to the received chain pitch t, the number of revolution per minute of the driver sprocket is checked for compliance with the permissible number of revolution per minute. The number of revolution per minute allowed for the 2R-44.45-344 type chain is $[n_1] = 400\ rpm$ according to the available data. Considering $n_1 = 72rpm$, we can see that the condition $n_1 \leq [n_1]$ is fulfilled.

The linear speed of the chain is determined by the following expression:

$$v = \frac{Z_1 \cdot t \cdot n_1}{60000}, \tag{1.6}$$

based on the expression chain speed is equal to:

$$v = \frac{23 \cdot 44.5mm \cdot 72}{60000} = 1{,}227\,\frac{m}{sek}.$$

The value of the rotational force on the drive shaft of the chain drive was determined as follows:

$$F_t = \frac{N_2 \cdot 10^3}{v}, \tag{1.7}$$

where $N_2 -$ is the power on the drive shaft of the chain drive, which was determined by the following expression:

$$N_2 = N_1 \cdot \eta_r, \tag{1.8}$$

we determine the calculated value of the power on the drive shaft of the chain drive from the expression:

$$N_2 = 11 \cdot 0{,}84 = 9{,}24\ kVt.$$

(1.7) we determine the value of the rotational force on the drive shaft of the chain drive, putting the values obtained in the expression:

$$F_t = \frac{9{,}24kVt \cdot 10^3}{1{,}227\ m/sek} = 7530{,}56N.$$

The value of the pressure applied to the chain hinge is checked according to the obtained chain parameters using the following expression:

$$P = \frac{F_t \cdot k_e}{A_{tay}} \leq [P], \tag{1.9}$$

according to the expression,

$P = \frac{7530{,}56 \cdot 2{,}435}{946mm^2} = 19{,}4MPa \leq [32\ MPa]$ the condition is met .

The number of chain links is determined as follows:

$$a_t = \frac{a}{t} = \frac{(30 \div 50)t}{t} \tag{1.10}$$

Taking into account the location of the device that distributes the seed in the bunker to the linters, it is desirable to take a value of $a_t = 50$.

We determine the sum of the number of sprocket teeth as follows:

$$z_{\sum} = z_1 + z_2 = 23 + 92 = 115.$$

To simplify calculations, we introduce the following notation:

$\Delta = \frac{z_2 - z_1}{2\pi} = \frac{92-23}{2 \cdot 3{,}14} = 10{,}99,$

We determine the number of links in the chain:

$$L_t = 2a_t + 0{,}5z_{\sum} \quad + \frac{\Delta^2}{a_t}, \tag{1.11}$$

According to the expression, $L_t = 2 \cdot 50 + 0.5 \cdot 115 + \frac{10{,}99^2}{50} \approx 160.$

We find the exact value of the distance between the axes by the following expression:

$$a = 0{,}25t[L_t - 0{,}5z_{\sum} \quad + \sqrt{(L_t - 0{,}5z_{\sum} \quad)^2 - 8\Delta^2}, \tag{1.12}$$

The value of the distance between the axes was determined by putting the existing values into the expression:

$$a = 0{,}25 \cdot 50[160 - 57{,}5 + \sqrt{10506{,}25 - 966.2408} = 2502{,}162mm.$$

We determine the diameters of the dividing circle of the driver and driven sprockets:

driver,

$$d_{D_1} = \frac{t}{sin\frac{180^\circ}{z_1}} = \frac{44{,}45\ mm}{\sin{(7{,}826)^\circ}} = 326{,}36mm,$$

driven, $$d_{D_2} = \frac{t}{sin\frac{180^\circ}{z_2}} = \frac{44{,}45\ mm}{\sin{(1{,}957)^\circ}} = 1303{,}52mm.$$

We determine the outer diameters of the driver and driven stars:

driver,

$$D_1 = t\left(ctg\frac{180}{z_1} + 0.7\right) - 0.31d_1 = 346{,}643\ mm,$$

driven,

$$D_2 = t\left(ctg\frac{180}{z_2} + 0.7\right) - 0.31d_1 = 1324{,}413\ mm.$$

We determine the forces acting on the chain:

rotational force: $F_t = 7530{,}56N$;

centrifugal force: $F_v = q \cdot v^2 = 14{,}4kg \cdot 1{,}227^2 = 21{,}68\ N$;

the force due to chain tension:

$F_f = 9{,}81 \cdot k_f \cdot q \cdot a = 9{,}81 \cdot 1{,}4 \cdot 14{,}4 \cdot 2{,}502162 = 494{,}851\ N,$

here $k_f -$ is the coefficient that takes into account the location of the chain, and we get the value $k_f = 1{,}4$ taking into account that the chain is located obliquely in the process we are considering.

We calculate the value of the load acting on the shaft:

$F_v = F_t + 2F_f = 7530{,}56N + 989{,}702N = 8520{,}262N$

The strength reserve coefficient of the selected chain drive is determined by the following expression:

$$s = \frac{Q}{F_t \cdot k_1 + F_v + F_f} = \frac{344{,}8 \cdot 10^3}{7530{,}56N \cdot 1 + 8520{,}262 + 494{,}851} = 20{,}84$$

We consider the condition that the determined strength reserve coefficient is greater than the determined reserve normative coefficient $s \geq [s]$ for the selected chain:

$$s = 20{,}84 \geq [s] = 8{,}1.$$

Summary. From the results of the above project, it can be concluded that the proposed chain drive structure can reduce the wear indicators of the chain elements and star teeth, and it can be seen that the value of the reserve coefficient $[s]$ has increased significantly.

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UDC 629.4.023.11

ANALYSIS OF EXISTING METHODS AND APPROACHES TO THE ASSESSMENT OF RESIDUAL RESOURCES OF TRACTION ROLLING STOCK

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Abstract:

Objective. The article presents an analysis of existing methods and approaches to assessing the residual life of elements of load-bearing structures of traction rolling stock. In this work, methods for assessing reliability indicators and reliability during the use of torsion action content are presented. The analysis of the characteristics characterizing the reliability of technical objects is presented. To confirm the validity of the forces acting on the motion, algebraic formulas are given.

Methods. Based on existing methods and approaches, statistical, quasi-static, dynamic, variable, multiple and low-cycle effects of loads were analyzed in detail. The Weibull equation, the Mazing principle.

Results. Structures of railway traction rolling stock during operation take on loads (static, quasi-static, dynamic, variable, multiple and low-cycle) that affect the design of the support at different levels and periods of use. At the same time, it causes both elastic and plastic deformations.

Conclusion. At the same time, it is necessary to achieve a uniform distribution of deformations and loads in the structure as a result of a gradual change and displacement of the mechanical properties of the

metal structure material. Consideration of the deformed state of the traction rolling stock structure in the kinetic sense and analysis of the boundary states based on the criteria of cracks or permissible impact on the structure allows us to determine the appropriate limiting forces, the number of cycles and time characterizing the bearing capacity.

Keywors: residual resource, reliability, bearing capacity, statistical load, quasi-static load, dynamic load, variable, multiple and low cyclic loads, Weibull equation, Masing principle.

Introduction. The practical significance of the problem of the residual life of traction rolling stock in railway transport is even greater. Although at the current pace of scientific and technological progress, the moral wear of railway rolling stock machines is going faster than before, the real resource in many industries has not reached economically acceptable values. One of the biggest problems we face is that replacing obsolete railway equipment with new ones is not economically justified. The reason is that, although most of the machines used in railway transport are obsolete, their initial resource has not yet been completely exhausted [1,2,3,4,5]. Currently, the problem of determining the optimal variant of energy and labor costs spent on replenishing the fleet of locomotives and their repair, the solution of which contributes to the fulfillment of the tasks facing rail transport, is urgent.

Methods. To date, two directions of assessing the reliability of traction rolling stock have been formed. The first of them is operational reliability, the basic principles and methods of which are formulated by S. V. Serensen, V. P. Kogaev, R. M. Schneiderovich, R. V. Kugel, B. S. Kuznetsova, A.M. Scientists such as Sheinina have studied. The analysis of work in this direction shows that the procedure for determining reliability indicators in the presence of information about the nodes of traction rolling stock is reduced, so to speak, to the appropriate methods. However, research methods and operational reliability also have some disadvantages, the main one of which is that the duration of information payment takes a lot of time.

The second direction is the determination of reliability indicators in the design of the structure. In this direction, it should be noted that Academician E. A. Chudakov's method of calculating structures for strength in the form of reserve coefficients does not allow us to proceed to estimating the resource of parts, as for the intuitive forecasting method, which is advisable if the developed parts are compared with similar parts that have proven themselves well in the work [6,7,8].

According to GOST R 27.002-2009 (reliability in technology. Terms and definitions) reliability refers to the availability property and the reliability and maintenance properties that affect it. Reliability is a complex [9,10,11] that performs specified functions, preserves specified operational indicators, maintains its operational indicators within certain limits for a specified period of time or during the required working time.

Reliability indicators can be partially determined using stands at manufacturing plants and during various tests at repair facilities, but the most complete information about operational reliability can be obtained using archived data in repair depots. Information is collected on traction rolling stock, while not only malfunctions and malfunctions, various impacts (maintenance, current and major repairs) are recorded, but also the operating conditions of the rolling stock, for example; the transported cargo, the length of traffic, the percentage of traffic on various roads, etc.

Based on the results of observations, typical malfunctions of elements are identified, the causes of their occurrence are identified, details that limit their reliability are identified, parameters and types of resource allocation laws of these

parts are determined, spare parts standards are evaluated, etc. [12,13,14].

Results. Improving the reliability of machines, equipment and devices is one of the priority areas of technology and technology development for the coming decade. The most important property characterizing the reliability, service life and resource intensity of technical objects. The theory of reliability allows us to assess the influence of factors on the average resource and resource allocation, to assess the residual resource in combination with methods and means of technical diagnostics.

Technical resource is a value that characterizes the reserve of useful operation of an object. According to GOST 27.002-89, a resource is the total uptime of an object from the beginning of its operation or restoration after repair to the transition to the limit state [15].

Units of measurement of residual resources are selected for each industry separately in relation to each class of machines, aggregates and structures. The best and universal unit from the point of view of theory and general methodology is a unit of time.

Firstly, the operating time of a technical facility as a whole includes not only the time of its useful work, but also the total working time and breaks. At the same time, in these gaps, the object is exposed to environmental influences and loads arising during operation. Thus, the aging process, when the properties of materials change, proportionally leads to a decrease in the total resource [16,17].

Secondly, the resource is closely related to the service life, which is defined as the calendar duration of the object's operation before the transition to the limit state and is measured in units of time. The service life of the object before decommissioning (planned, standard service life) is largely due to the pace of scientific and technological progress in this area.

Thirdly, when predicting the duration of the functioning of an object in the tasks of forecasting the residual resource of its functioning for a certain period of time, this is a random process, the argument of which is time. Thus, at runtime it is to determine the value of the random time function here [18].

Structures of railway traction rolling stock during operation take on loads (static, quasi-static, dynamic, variable, multiple and low-cycle) that affect the design of the support at different levels and periods of use. At the same time, it causes both elastic and plastic deformations. Loads (impacts) are characterized by the degree of propagation in space, the speed of their movement and other estimated parameters. To check the operability of the design of the traction rolling stock, the impact class and its characteristics are established, which should be reflected in the model. The belonging of an effect to a certain class is determined by its most important properties, depending on which the following classification is considered [19].

- Statistical (or quasi-static) effects that do not lead to a significant acceleration in the design.

Static loads refer to the effect of time on the development of fatigue failure of the structure or to single or less frequently repeated loads. Such loads (usually to a lesser extent), which can lead to a breakdown or breakdown of the structure due to fatigue, affect most traction moving parts. To do this, the calculation of the load-bearing capacity of traction moving parts should be based on statistical or repetitive statistical load-bearing capacity and endurance.

The load capacity of traction moving components affected by static load should be considered because of their effect on plastic deformation and movement, since in some cases the limiting state of the part should correspond to the presence of plastic deformations in it.

$$n = \frac{Q_{\text{пред}}}{Q_T} \cdot \frac{Q_T}{Q_{\text{раб}}} = \frac{Q_{\text{пред}}}{Q_{\text{раб}}} \cdot n_T \qquad (1)$$

In this place;

$Q_{\text{пред}}$ — the maximum load corresponding to the maximum permissible movement, load-bearing capacity or fatigue, depending on the criterion by which

In this expression, the coefficient $Q_{\text{пред}} / Q_{\text{раб}}$ shows how much the margin of safety differs from the usually calculated yield strength when calculating static load-bearing capacity.

- A dynamic effect that cause significant accelerations due to the variability of vibrations close to the main tone.
- O impact variables that change their values or positions at different points. In many cases, exposure variables are not constant. Then they can be characterized by discrete quantities, and they are considered as short-term processes over a period of time during which the effect exists.

Then these data can be characterized by discrete quantities, and during the period of time during which the effect exists, they are considered as short-term processes. If these loads exceed a certain level, irreversible changes will begin to occur in the metal structure element, which will lead to cracking. The crack, developing gradually, eventually leads to the rapid destruction of the elements of the traction rolling stock. This phenomenon is called metal fatigue.

The physicomechanical nature of the fatigue elimination process is studied by various methods (X-ray, microscopic, hardness and microhardness measurement, polarization-optical method in silver chloride, electric, etc.).

This is very convenient for solving cyclic problems, since this implies the similarity of single and cyclic deformation curves, and, consequently, the solution of the cyclic problem can be obtained on the basis of static solutions.

the static load-bearing capacity is determined;

Q_T — appropriate load to reach the current limit at the sharpest points of the structure;

n_T — safety margin when calculating the current strength.

In some cases, it is convenient to use the equation proposed by Weibull to describe fatigue curves.

$$(N_{Б} + B)(\sigma - \sigma_{-1})^q = K \qquad (2)$$

In this place;

σ_{-1}— the ultimate strength of the design sample, i.e. the highest value of the maximum cycle stress that it can withstand without breakage,

$N_{Б}$— it is called a test base (usually 10 million cycles for steel samples, 50-100 million cycles for light alloy samples).

The margin of safety in the calculation of static load-bearing capacity can be determined as follows:

- And the short-term effects that affect the structure over time are much less than the lifetime of the structure. The service life of a structure is a process with an interval of several iterations, which is affected by the load.

The generalized Masing principle is defined for a cyclic deformation curve as follows.

$$\frac{\bar{S}}{S_T^{(K)}} = f\left(\frac{\bar{E}}{S_T^{(K)}}\right) \qquad (3)$$

In this place;

$S_T^{(K)}$ – depending on the number of cycles, the coefficients are determined;

$\bar{E}$ – accumulated fatigue in the structure.

Prolonged exposure to its element during the time corresponding to the service life of the structure. It is a continuous or continuous process with relatively small changes in load times during the same type of work cycles. At the

same time, changes in the load value are determined by the characteristics of the locomotive equipment and its purpose (shunting, luggage).

Parts of various machines used in many machines, especially traction rolling stock, diesel engines, reactors, work for a long time under load at high temperatures. Some features of plastic deformation under these conditions lead to breakage or failure of its components. Deformations caused by compression can reach the limit values at which the machine will fail in time. As a result, the metal gradually weakens due to elastic stresses at the connection points of the structure, and the possibility of reuse of a certain service life by reducing the limiting stresses over time leads to a slow increase in deformations over time under the influence of constant loads.

In general, in order to determine the maximum load on distortion, it is necessary to determine the dependence of this load on deformations, calculate the final accumulation. It is necessary to determine the maximum number of cycles (time) for the specified time (number of cycles) and determine the endurance reserve.

$$n_N = \frac{N_{\text{пр}} Q}{N_{\text{раб}}} \quad \text{and} \quad n_t = \frac{t_{\text{пр}} Q}{t_{\text{раб}}} \qquad (4)$$

Special effects resulting from very rare effects. With the help of modern engineering programs, it is necessary to determine the probability of their occurrence [20].

Conclusion. During long-term operation of structural elements under alternating stresses (millions), the limiting state is determined mainly by changes in the state of the metal, which gradually accumulate in it as a result of deformation (fatigue process). If the structures operate at high temperatures, time becomes one of the factors leading to the occurrence of boundary conditions. At the same time, it is necessary to achieve a uniform distribution of deformations and loads in the structure as a result of a gradual change and displacement of the mechanical properties of the metal structure material. Consideration of the deformed state of the traction rolling stock structure in the kinetic sense and analysis of the boundary states based on the criteria of cracks or permissible impact on the structure allows us to determine the appropriate limiting forces, the number of cycles and time characterizing the bearing capacity.

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UDC 677.052

DETERMINATION OF THE FRICTION FORCE BETWEEN THE COMPOSITE FEEDING CYLINDER AND THE FIBER ROVE

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Annotation. The article covers the process of pushing the rove by composite feeding cylinder in discretization cross-sectional surface in an appropriate form by squeezing, which, in the existing construction, mainly depends on the coefficient of friction between the fiber and the cylinder and the pressure force. Analytical solutions of depending of the newly designed, i.e., the composite feeding cylinder on the rigidity of the rubber bushing are given. In the process of impacting the fiber rove with the cylinder that provides the content, forces are generated, and the cylinder's gravity force, centrifugal force; rubber bush unit force, fiber plug unit force; friction force and reaction force were calculated.

Keywords: friction force, fiber rove, spinning machine, discretization, discretization drum, fiber, belt, feeding cylinder, rubber rigidity, speed, grip angle, hardness, deformation, force.

Introduction. Textile industry is one of the important strategic sectors of the republic. In order to realization the decrees and decisions of the President of Republic, technical re-equipment and modernization of textile enterprises for the production of high-quality spun yarn and textile products, i.e., innovative technological processes and production automation, are being implemented. In our country, it is planned to increase the export of light industrial products to 7 billion USD by 2025, and in 2019-2025, it is planned to increase the production volume by 3.8 times, ready-made textile products by 3 times, and knitted products by 3.1 times [1].

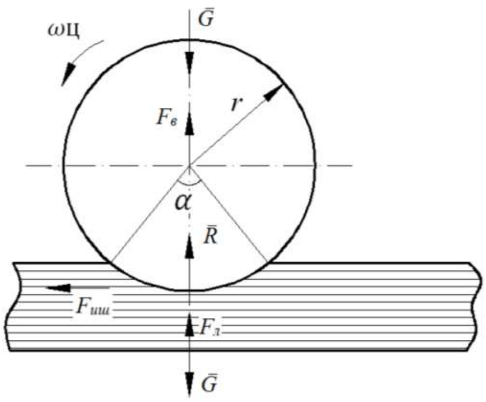


Fig. 1. Calculation scheme of impact of composite cylinder and fiber tape and the process of its application in practice

The composite feeding cylinder compresses the rove in the course of work and pushes it to the discretization zone in the space of the cross-sectional surface of the appropriate shape (2×9) mm^2. In the existing construction, it mainly depends on the friction coefficient between the fibers and the cylinder and the pressure force [2].

The recommended composition also depends on the rigidity of the rubber bushing of the supply cylinder. The following forces are generated during the interaction of the fiber coil with the cylinder providing the content: cylinder gravity, centrifugal force; rubber bush unit force, fiber plug unit force; friction force and reaction force.

The calculation scheme of the impact of the feeding cylinder and the fiber rove in discretizing zone and the process of its application in practice are shown in Fig. 1.

In this case, the mass of the feeding cylinder consists of the mass of the shaft $m_в$, the mass of the belt rubber bush $m\tau_в$ and the mass of the fittings m_p.

Therefore:

$$G_т = (m_в + m\tau_в + m_p)g \quad (1)$$

where g is the acceleration of free fall.

Centrifugal force of the feeding cylinder [3]:

$$F_{m\mu} = (\frac{\pi n_ц}{30})(m_в + m\tau_в + m_p)\cdot r \quad (2)$$

where, $n_ц$ is the rotation frequency of the feeding cylinder; π=3.14; r is the radius of the tooth of the cylinder head.

It should be noted that the restoring force of the rubber bushing, as well as the restoring force in the vertical displacement of the fiber rove, is directed upwards, the values of which are considered account by the following general unitary force [4]:

$$F_б = \frac{c_{вт}\cdot c_л^{r^2}}{c_{вт}+c_л}(1-cos\frac{\alpha}{2}) \quad (3)$$

$$F_{иш} = fN \quad (4)$$

where, *f* is the coefficient of friction; *N* is total force; α is the coverage angle of the rove deformation zone.

The contact surface of the feeding cylinder with a corrugated fittings and the fiber rove is determined by the following expression [5]:

$$S_\pi = 2rlsin\frac{\alpha}{2} \quad (5)$$

where *l* is the length of the cylinder.

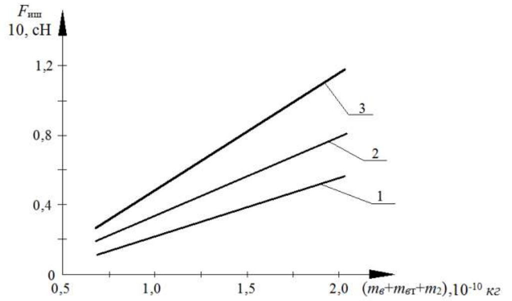
Considering the above, the force of friction between the surface of the discretizing zone providing the cylinder and the fiber rove was determined by the following expression [6]:

$$F_{иш} = \left\{(m_в + m_{вп} + m_2)\cdot\left[\partial + (\frac{\Pi n_ц}{30})^2\cdot r\right] + \frac{c_{вт}\cdot c_л^{r^2}}{c_{вт}+c_л}\cdot(1-cos\frac{\alpha}{2})\right\}\cdot f \quad (6)$$

When deriving the resulting expression, the movement is determined in a stable mode, that is, for the calculation of the value of the acceleration equal to zero. In order to determine the dependence of the friction force on the parameters of the cylinder, their calculated values were considered in the following ranges:

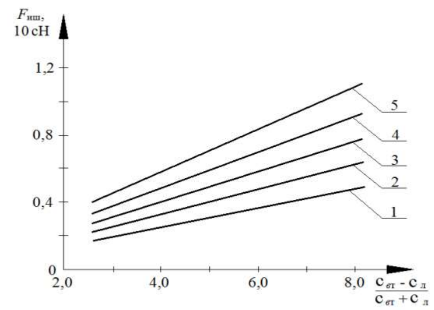
$n_ц$=(10÷20) rpm; r=(9÷11)·10^{-3} m; $m_в$=(100÷124)·10^{-3} kg; $m_{вт}$=(15÷25)·10^{-3} kg; m_2=(30÷45)·10^{-3} kg; α=(8°÷16°); $c_{вт}$=(15÷25)·sN/mm; $c_к$==(4,5÷7,0)·sN/mm; f=0,2÷0,3.

As a result of the solution of the problem, a graph of the dependence of the force of friction between the discretizing zone of composite feeding cylinder and the fiber rove was built. The graphs of the dependence of the total mass of the cylinder containing the contents of the proposed discretization zone on the friction force with the teeth fittings set and the fiber rove are shown in Fig. 2.



1-f=0.2; 2-f=0.25; 3-f=0.3

Fig. 2. Graphs of the dependence of the total mass of the cylinder containing the content of the recommended discretization zone on the friction force with the teeth fittings set and the fiber rove



1–r=8.5·10^{-3}m; 2–r=9.0·10^{-3}m; 3–r=9.5·10^{-3}м; 4–r=10.0·10^{-3}м; 5–r=10.5·10^{-3}м;

Fig. 3. Graphs of dependence of the friction force between the discretizing zone between the cylinder and the fiber rove on the coefficients of uniformity of the cylinder rubber bushing and the fiber rove

As we know [7], as the mass values increase, the pressure force on the friction surfaces increases, that is, the friction force increases. Based on the analysis of the graphs in Fig. 3, when the total mass of the contained cylinder increases from 0.75·10^{-1} *kg* to 2.0·10^{-1} *kg* and the coefficient of friction is at a minimum value of 0.2, the $F_{уш}$ values range increases linearly from 0.1·10 *sN* to 0.58·10 *sN*. Correspondingly, when the friction coefficient increases to 0.3, the values of $F_{уш}$ increase from 0.315·10 *sN* to 1.18·10 *sN* in the linear bond.

In the discretization zone, sufficient friction force is required to move the fiber coil to the workpiece at a specified speed without slipping.

But on the other hand, it should be noted that as the pressure on the fiber pile increases, the damage to the fibers also increases. Therefore, in order to ensure that the friction force is in the range of (0.8÷1.1)·10 *sN,* recommended values for the total mass of the composite feeding cylinder in the range of (1.8÷2.5) ·10^{-1} *kg*, and *f* =0,2÷0,25.

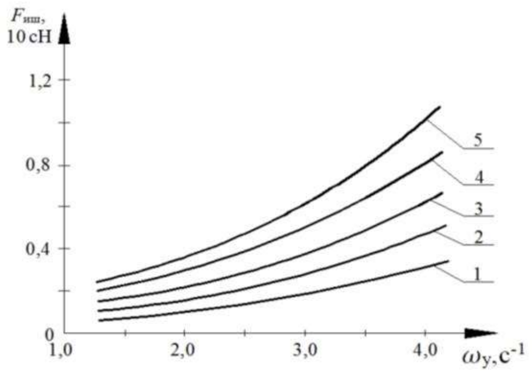
The friction force is directly dependent on the quality of the rubber bushing of the supplying cylinder and the value of the deformation of the fiber, that is, its density. Fig. 3 shows the graphs of dependence of the friction force between the cylinder feeding the discretization zone and the fiber rove on the coefficients of uniformity of the rubber bushing of the cylinder and the fiber rove. The analysis of the constructed graphs requires that when the total coefficient of friction is from 8.0 *sN/mm* to 2.8 *sN/mm* and the outer radius of the cylinder is *r*=8.5·10^{-3} *m,* the frictional force increases from 0.19·10 *sN* to 0.52·10 *sN* in a linear bond [8].

Moreover, when the radius of the cylinder increases to *r*=10.5·10^{-3} *m*, the friction force between the corrugated gasket of the corresponding feeding cylinder and the fiber rove increases linearly from 0.45·10 *sN* to 1.12·10 *sN*. Therefore, in order to increase the friction force between the feeding cylinder and the fiber rove, it is appropriate to choose their coefficients of uniformity in the range of (7.0÷9.0) *sN/mm*.

In this case, it is recommended that the gear radius of the feeding cylinder is *r*≤(9.5÷10.5)·10^{-3} *m*. Discretization zone feeding speed, that is, productivity depends mainly on the angular speed of the feeding cylinder. The angular speed shows a sufficient distance between the cylinder

and the fiber rove. Discretization zone feeding speed, that is, productivity depends mainly on the angular speed of the feeding cylinder. Angular speed shows enough between the cylinder and the fiber coil [9, 10].

It can be seen from the graphs of the dependence of the friction force between the friction force between the discretizing zone of the feeding cylinder and the fiber rove on the angular speed of the cylinder that when the angular speed of the cylinder increases from 1.5 s^{-1} to 4.0 s^{-1} and the dip angle is α=8, the values of $F_{uш}$ increase from 0.08·10 *sN* to 0.36·10 *sN* in nonlinear bond. It can be noted that when the angle of immersion of the differentiating cylinder into the pile increases to 16˚, the friction force increases from 0.28·10 *sN* to 1.09·10 *sN* in a nonlinear bond (Fig. 4, graphs 1-5).



1-α=8˚; 2-α=10˚; 3-α=13˚; 4-α=14˚; 1-α=16˚

Fig. 4. discretizing zone of the feeding cylinder and the fiber rove on the angular speed of the cylinder

Therefore, it is effective to increase the angular speed of the cylinder in order to increase the friction force between the corrugated fittings of the composite feeding cylinder and the fiber rove in the discretization zone. Recommended values are $\omega_ц$=(3÷3.5)s^{-1}; α=(12˚÷14˚)

Conclusion.

1. Mathematical expression representing the vertical oscillations of the discretizing feeding drum taking into account the rigidity of the belt shock absorber has been obtained. The formula for determining the friction force between the discretizing cylinder and the fiber rove has been recommended.

2. Graphs of dependence of the total mass of the composite feeding cylinder of the recommended discretization zone on the friction force with the teeth fittings and the fiber rove have been constructed. In order to ensure the friction force is in the range of (0.8÷1.1)·10 *sN,* the recommended values of the total mass of the composite feeding cylinder are (1.8÷2.5)·10^{-1} *kg*, and f=0.2÷0.25.

3. Graphs of dependence of the friction force between the discretizing zone between the feeding cylinder and the fiber rove on the coefficients of uniformity of the rubber bushing of the cylinder and the fiber coil show that in order to increase the friction force between the feeding cylinder and the fiber rove, it is advisable to choose their coefficients of uniformity in the range of (7.0÷9.0) *sN/mm.* In this case, it is recommended that the outer radius of the supply cylinder be *r*≤(9.5÷10.5)·10^{-3} *m*.

The graphs of the dependence of the friction force between the cylinder and the fiber rove, which provides the discretizing zone, on the angular speed of the cylinder have been determined. It is considered effective to increase the angular speed of the cylinder in order to increase the friction force between the corrugated fittings of the composite feeding cylinder and the fiber rove in the discretizing zone, where

$\omega_ц$=(3÷3.5) s^{-1}; α=(12˚÷14˚) values have been recommended.

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FORECASTING THE PROSPECTIVE VOLUME OF CARGO TRANSPORTATION FOR THE DEVELOPMENT OF THE TRANSPORT NETWORK

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Abstract:

Objective. The content of the article is mainly concerned with solving the problem of efficient distribution of cargo flows in the transport network and their optimal development in accordance with the growth (dynamics) of traffic volumes, taking into account the throughput of the road. For this, methods for generating initial data and determining their reliability are presented. As an example, predictive calculations

of an increase in the volume of cargo transportation in the Surkhandarya region were performed using the time series method and an analysis was presented.

Methods. Statistical analysis, economic forecasting, dynamic series methods, and least squares methods were used widely in the article.

Results. The distribution of flows in the regional transport network and their development in accordance with the perspective of the dynamics of flows is an important task. In solving this problem, the perspective flow is the main source of information. The article presents the flow forecast at the site, its prognostic equations are determined, the indicators achieved by the time series method and the results of the forecast are compared, and a conclusion is made about its reliability.

Conclusion. Really achieved indicators and predicted results are compared and a conclusion is made about their reliability. For example, for 2021, the maximum value of the time series forecast is 80801.6, the minimum value is 74867.6, and the actually achieved indicator is 73779.7. Therefore, the values obtained for the calculation can be called reliable, given that they do not have a big difference.

Keywords: transport, transport network, transport capacity, prediction (prognosis), dynamic series.

Introduction. Modernization and further development of production, technical renewal and diversification require the widespread introduction of innovative technologies. It is known that the modernization and further development of production requires the expansion and improvement of the efficiency of the transport infrastructure - all elements of the network of railway and road transport, respectively, technical and technological means of transport.

Transport network and the size of traffic (transportation) are the primary data in solving the issues of effective distribution of existing and prospective flows in the transport network and their optimal development, they are reflected in the existing distribution of productive forces. The volume of transportation, that is, the transportation plan based on the volumes of production and consumption of various goods at specific points, can be set in the form of a transportation matrix.

Methods. Statistical analysis, economic forecasting, dynamic series methods, and least squares methods were used widely in the article.

Results. The traffic volume is the initial information for the distribution of flows in the transport network and their further development. The article presents general methods for predicting the intensity of traffic on public roads and the urban transport network and concludes that they are reliable [1].

Transport forecasting methods are used as an instrument in the assessment of future loading of transport types and their elements. On the example of the container cargo turnover of Russian seaports, the calculation forecast of the studied indicators with the forecast of industry experts was analyzed using the dynamic series method [2].

The issues of network development based on the distribution of transport flows in the transport network were reflected in the research works of a number of scientists, including I. Kabashkin, 2015, V.I. Zhukov, S.V. Kopylov, 2015, Mouna Mnif, Sadok Bouamama, 2017.

A general assessment of the level of transport provision of the region was made according to the forecast data of the average length of transport roads per 1000 sq.km of area and 1000 inhabitants [3].

In order to effectively absorb future transport flows in the transport modes, the transport multi-network of the region was formed and the transport flows were distributed in the network. "Narrow" sections of the transport network were identified and recommendations for their development were developed [4, 5, 6, 7].

Discussions. When solving the problem of distribution of load flows in an extended network, the transport network and transport dimensions are consider as initial information. Therefore, it is very important to determine the dimensions of the future transport. Transportation dimensions, that is, the volume of

production and consumption of various cargoes at specific points, or the transportation plan for the volume of all cargoes, can be given in the form of a transportation matrix, where the data is displayed for each shipping and receiving points of the network [8].

Prospective inter-node correspondences are given in the form of a transportation matrix. In the transport network, the load flows are brought to the traffic flow and the speed of movement for this network is determined.

Traffic speed prediction is based on gravity modeling, with separatemodelingfor freight and passenger traffic. The following formula for shipping [9]:

$$N = \frac{Q_c}{275 q_{o'r} K_{yuk} K_n}, \quad (1)$$

where is the predicted movement speed;

Q_c – the available volume of cargo transportation;

$q_{o'r}$ – the average carrying capacity of the vehicle in use;

K_{yuk} – load capacity utilization factor;

For passenger transport, the capacity of buses is assumed instead of carrying capacity in this formula.

It is known that economic forecasting is used to assess the future development strategy of the industry. This situation makes it possible to develop recommendations for effective management of production. Based on the determination of the economic perspective, the initial data will be able to justify the organization of the management of the transportation process and increase productivity. A table was created based on the data on the volume of cargo transportation within the region (2010-2021) (Table 1). The dynamic range method is mainly used as part of determining the long-term perspective in shipping. This method is based on determining the target using data indicators of the past time. The increase in the volume of cargo transportation in the period 2010-2030 of the researched area was calculated based on mean square values (Fig. 1).

Table 1

The volume of cargo transportation by year in Surkhandarya region, thousand tons (2010-2021)

Indicators	Years 2010	2011	2012	2013	2014	2015
Cargo volume, thousand tons	22 134,9	25 366,3	28 662,8	32 204,0	41 660,9	50 769,5
Indicators	Years 2016	2017	2018	2019	2020	2021
Cargo volume, thousand tons	57 618,1	58 857,6	61104,9	69 080,9	72 227,2	73 779,7

Indicator	Years 2022	2023	2024	2025	2026	2027
Prospective cargo volume, thousand tons	82994	88462	93486	97226	97952	98214
Indicator	Years 2028		2029		2030	
Prospective cargo volume, thousand tons	100430		107977		112277	

A transportation checkerboard of resources is created, reflecting the existing or planned transportation volumes for each type of cargo. It allows to determine the cargo turnover of transport companies.

It is desirable to compare several natural indicators with the dynamic series method. Another important requirement is the need to establish a logical relationship when selecting the rows to be compared. A detailed clarification of such series allows to reflect the functional dependence of the investigated indicators and, in turn, to determine their correlation.

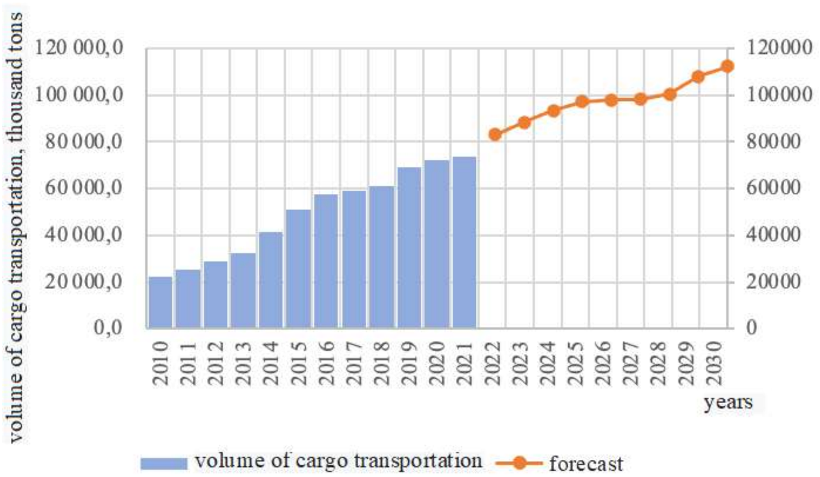

Figure 1. Shipping volume, thousand tons

In simple cases, the problem is reduced to an equation in the form of a linear relationship [9].

$$y = a_0 + a_1 t, \qquad (2)$$

where the carrying capacity; constant value; coefficient; account period.

a_0, a_1 parameters are determined by the method of least squares [9].

We will carry out calculations to forecast the growth of freight traffic in the studied area. First, we form a dynamic series and the first three graphs in Table 2 are filled (Table 2).

Table 2

Initial data for determining the parameters of the equation

Years	Time in years, t	Cargo volume, thousand tons	t^2	ty_t	y_t^2	a_1t	$\bar{y}_t$	$y_t-\bar{y}=\varepsilon_t$	ε_t^2
2010	1	22 134,9	1	22135	489953798	5159,8	21076,8	0,2	0,1
2011	2	25 366,3	4	50733	2573796703	10319,6	26236,6	-870,3	757 422,1
2012	3	28 662,8	9	85988	7394004935	15479,4	31396,4	-2 733,6	7 472 569,0
2013	4	32 204,0	16	128816	16593561856	20639,2	36556,2	-4 352,2	18 941 644,8
2014	5	41 660,9	25	208305	43390764720	25799	41716	-55,1	3 036,0
2015	6	50 769,5	36	304617	92791516689	30958,8	46875,8	3 893,7	15 160 899,7
2016	7	57 618,1	49	403327	162672426933	36118,6	52035,6	5 582,5	31 164 306,3
2017	8	58 857,6	64	470861	221709892977	41278,4	57195,4	1 662,2	2 762 908,8
2018	9	61 104,9	81	549944	302438513125	46438,2	62355,2	-1 250,3	1 563 250,1
2019	10	69 080,9	100	690809	477217074481	51598	67515	1 565,9	2 452 042,8
2020	11	72 227,2	121	794499	631228978801	56757,8	72674,8	-447,6	200 345,8
2021	12	73 779,7	144	885356	783855955021	61917,6	77834,6	-4 054,9	16 442 214,0

$y = a_0 + a_1 t$ a straight line graph is constructed (Fig. 2).

In order to determine the parameter values of the approximation equation by the method of least squares, the necessary calculation is performed and Table 3 is filled.

The correlation coefficient is calculated by the following formula:

$$r = \frac{n\sum ty_t - \sum y_t \sum t}{\sqrt{n\sum t^2 - (\sum t)^2}\sqrt{n\sum y^2 - (\sum y)^2}} = 0{,}978 \qquad (3)$$

The correlation coefficient showed that there is a strong relationship between the researched factors.

The parameter values of the equation are determined by the following formula:

$$a_1 = \frac{n\sum ty_t - \sum y_t \sum t}{n\sum t^2 - (\sum t)^2} = 5159{,}8, \qquad (4)$$

$$a_0 = \frac{\sum y_t - a_1 \sum t}{n} = 15917 \qquad (5)$$

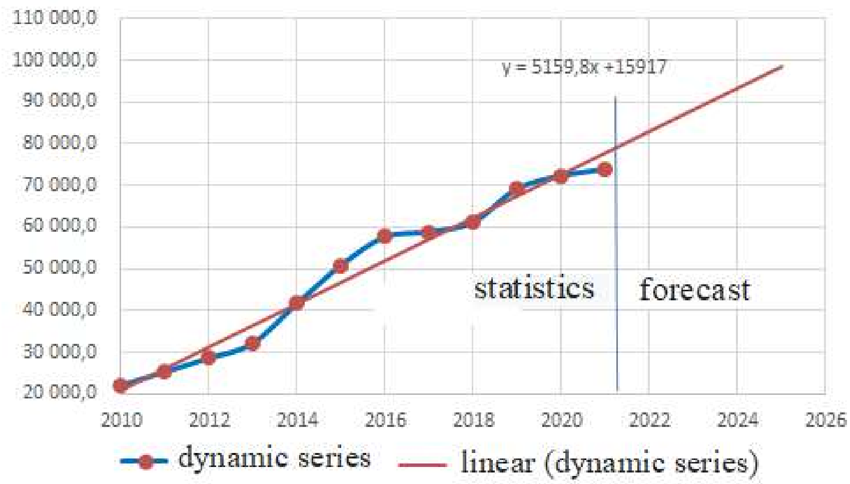

Figure 2. The growth of cargo transportation (2010-2025)

The mean squared error is defined as:

$$\sigma = \sqrt{\frac{\sum (y_t - \bar{y}_t)^2}{n-p}} = 2967, \tag{6}$$

$n-$ number of dynamic series equations; $p-$ the order of the equation representing the trend.

Table 1

Calculation of freight volume forecasting equations

Years	Time	$\bar{y} = a_0 + a_1 t$	$\bar{y} + \sigma_{\varepsilon t} = y, \max$	$\bar{y} - \sigma_{\varepsilon t} = y, \min$
2022	13	82994,4	85962	80026,4
2023	14	88154,2	91122,2	85456,2
2024	15	93314	96282	90616
2025	16	98473,8	101441,8	95775,8

The calculations obtained in the table are compared with the volume of actual cargo transportation.

Table 4

Comparison of actual achieved indicators and forecast results, thousand tons

Year	Forecasting by dynamic series method		Real achieved indicators
	Max	Min	
2018	65322,2	59388,2	61 104,9
2019	70482	64548	69 080,9
2020	75641,8	69707,8	72 227,2
2021	80801,6	74867,6	73 779,7

The transport network of the region is also the initial data for solving the problem of distribution of promising cargo flows in the network. Therefore, a ground transport multi-network of the Surkhandarya region was built [5].

The task of optimizing cargo in the network is reduced to the issue of creating the best system of roads. In this case, it will be more convenient to distribute the cargo to the next senders and recipients along the arc of these roads from one point to all other points.

The task is set as follows. It is required to determine the traffic density in each arc along with the approximate distribution of the load flow in the network in the shortest possible time. In this case, the following criteria must be met [6].

$$F = \sum_{ij}^{m} C_{ij} \cdot G_{ij} \text{ ёки } F = \sum_{st} C_{st} \cdot X_{st} \rightarrow \min$$

The idea of this method is as follows: a tree of the most profitable paths is built, the throughput of the most profitable path is determined $\mu(S,...i, j...t)$ $d_{st} = \min d_{ij}$.

A value is superimposed on the arcs of the path, taking into account the previously laid transportations. At the same time, the capacity of the track arcs is reduced by the value X_{st}. At full saturation, the last arc is excluded from further consideration. The issue of optimal distribution and development of the promising cargo flow of the region in the transport network is being solved.

Conclusion. To determine the distribution of flows in the transport network and plans for their future development, the choice of the method of forecasting the flows formed in the network and their determination is a very complex issue. Quick and high-quality determination of the future volume of transport helps the designer to develop more accurate plans for the development of the transport network.

The calculation results presented in the table do not have much difference from the values of real achieved indicators. Therefore, the method presented in the article allows to more accurately determine the dimensions of future transportation and ensures the reliability of the values obtained for the next calculation. Therefore, based on the distribution of flows in the transport network across the region, it becomes possible to identify "narrow" sections of the transport network and obtain plans for their development in accordance with the prospective growth of flows, as well as spend capital funds aimed at building roads in a targeted manner.

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UDC 621.323

CONTROL OF STATIC AND DYNAMIC MODES OF ASYNCHRONOUS MOTOR OF FODDER GRINDING DEVICES

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Abstract:

Objective. The article covers the ways of achieving energy savings by controlling the speed of asynchronous electric motors in a frequency method. Frequency control is economical because it increases the efficiency and reduces power loss by adjusting the speed of the asynchronous motor.

Methods. One of these methods is the method of controlling the speed of the asynchronous motor of feed crushers using a frequency converter. Start and control of the crushers is carried out using a frequency converter, which is set between the automatic and asynchronous motor and is controlled by the rotational frequency of the induction motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed crushers is carried out using a frequency converter.

Results. Asynchronous motors of feed crushers, the speed of which is adjustable by changing the frequency, along with saving the energy in static modes, saves the energy in dynamic modes as well. When starting the asynchronous motor of feed crushers without direct mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, if the inertia torque of the asynchronous motor and working mechanisms is large it lasts a very long time. As a result, the stator coil insulation heats up above the allowable temperature and the insulation fails.

Conclusion. As a conclusion, we can say that the frequency control of asynchronous motor in the operation of the asynchronous electric motor of feed crushers used in agricultural enterprises is economical, because the frequency converter allows the adjustment of the speed of the asynchronous motor and increase of the power coefficient of the electric drive.

Keywords: energy saving, electric drive, frequency converter, optimal control, energy criteria, operating mechanisms, energy efficiency, control systems, efficiency factor, power factor.

Introduction. As we know, today the agricultural sector in Republic is improving and developing rapidly. The asynchronous motor of feed grinding devices currently used in agriculture can be operated in several ways. For example, when we use feed grinding devices, used in agriculture, to grind corn seeds, very large current

steps are generated in the asynchronous motor of feed grinders, which is called the starting current or the current in the brake rotor. The starting current is 5-10 times higher than the rated current, has a short-term effect, and after acceleration, the current in electric motor drops to a minimum value. Therefore, during the operation of the feed grinding device, different methods of starting are used to reduce the starting current of the asynchronous motor of the device. In addition, a number of measures must be taken to stabilize the supply voltage.

Methods. One of these methods is the method of controlling the speed of asynchronous motors of feed grinding device using a frequency converter [1]. The starting and operation of feed grinding device is carried out using a frequency converter, which is set between the automatic machine and the asynchronous motor and is controlled by the rotational frequency of the asynchronous motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed grinding device is carried out using a frequency converter. Asynchronous electric drives, the speed of which can be adjusted by changing the frequency, can save energy in static modes, as well as efficient use of electricity in dynamic modes [1]. When starting asynchronous motors without direct mains voltage control, the starting current is 5-7 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, and if the moment of inertia of the asynchronous motor and the working mechanism is large, the transition process will take a very long time [2]. As a result, the stator coil insulation heats up above the allowable temperature, which leads to the fail of the insulation. Therefore, when starting asynchronous motors, the speed of which is controlled by changing the frequency, controlled by a certain pattern, it prevents the stator current from overheating, and then the induction motor is started normally in the thermal mode [3]. It is known that large electromagnetic moments and currents occur during direct starting of asynchronous motors. Large-amplitude oscillations of electromagnetic moments can create dangerous dynamic loads in the stator winding of asynchronous motor, and can cause mechanical stresses in the kinematic chains of an electric drive.

Fig. 1 shows closed functional circuit of frequency control using an asynchronous motor of feed crusher.

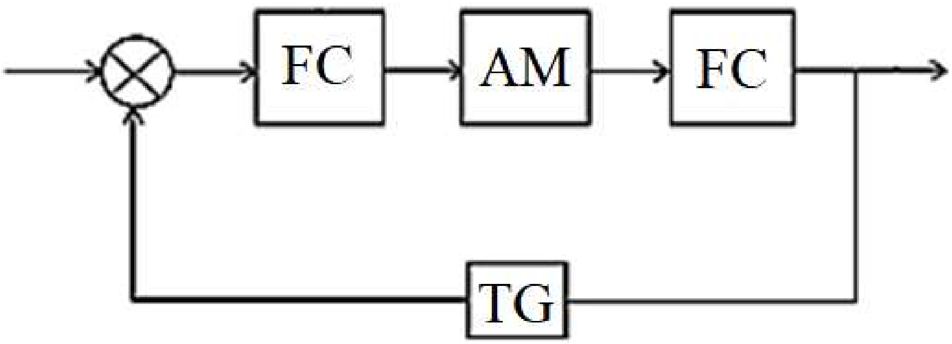

Fig. 1. Closed functional circuit of frequency control using an asynchronous motor of feed crusher:

FC- Frequency converter,AM- Asynchronous motor, TG- Taxogenerator, FC – Feed crusher

Therefore, in starting the asynchronous motor of feed grinding devices and ensuring a smooth flow of stops, that is, preventing the formation of large dynamic voltages prolongs the life of the asynchronous motor. As an example, the description of the change in the instantaneous value of the electromagnetic moment $M_*(t)$ at the time of direct starting of the asynchronous motor of feed grinding device used in agriculture is given in (Fig. 2).

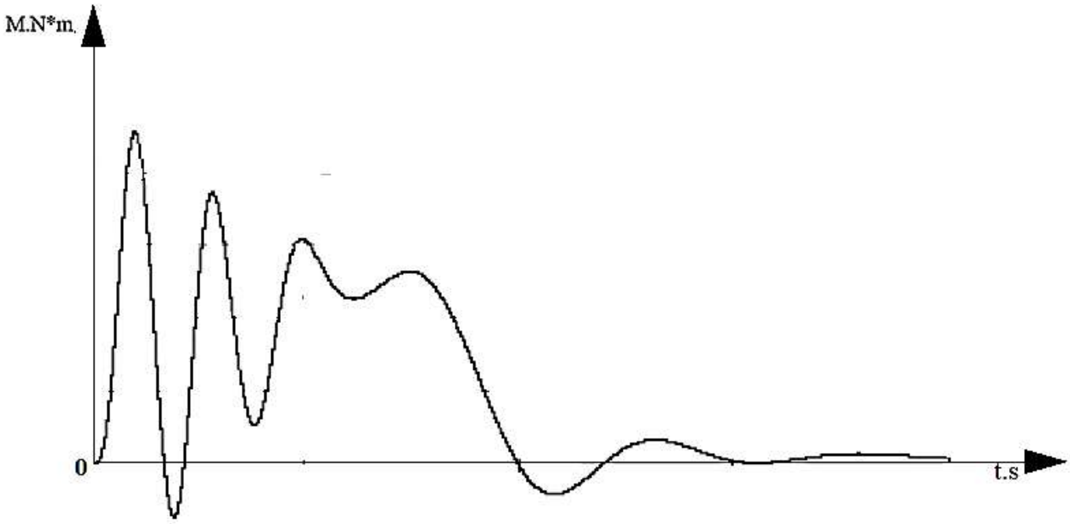

Fig. 2. Oscillogram of instantaneous values of the electromagnetic moment $M_*(t)$ at the direct starting of asynchronous motor of the feed grinding device [4]

In our next graph, in the same situation, the oscillogram of change in instantaneous values of the angular speed $\omega_*(t)$ at the time of direct starting of asynchronous motor of feed grinding device used in agriculture is shown in (Fig. 3).

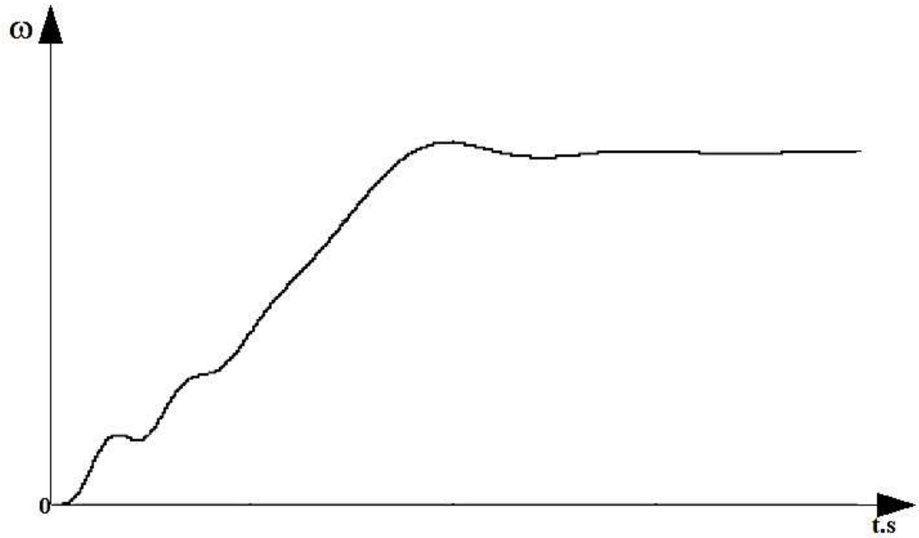

Fig. 3. Oscillogram of the change in instantaneous values of the angular velocity $\omega_*(t)$ at the time of direct starting of the asynchronous motor of the feed grinding device [4]

At present, one of the ways to optimize the processes of starting and stopping frequency-controlled asynchronous motors and improving its static and dynamic characteristics is to generate a variable amplitude voltage in the stator windings of asynchronous motor. This method is also called the parametric method, which is common due to its positive properties. Its advantage is simplicity and ease of technical production. The problem of optimal parametric control of the asynchronous motor of feed grinding device in agricultural enterprises is realized as follows. We determine the coordinates to be controlled, which can be axes, electromagnetic torque, rotor speed, etc., as well as the optimal control effect during starting the asynchronous motor to the nominal speed and complete stopping of the rotor speed during stopping.

As a control indicator we take the relative value of *γ*, i.e. stator winding voltage. Optimization is carried out on the principle of maximum and based on the mathematical model by the Newton-Rawson method, the frequency of which is assumed to be 50 Hz [5]. When the induction motor is started on an open system, the smooth changes in the stator winding voltage can reduce the shock moments, starting currents, power dissipation and reactive power values consumed [4].

The next graph (Fig. 4) shows the smooth starting of the asynchronous motor of feed grinding device used in agriculture by changing the frequency speed of the asynchronous motor and change in its energy performance [5-7]. Starting the asynchronous motor of agricultural feed grinding devices with a smooth frequency change, the transition processes in the change of quality indicators and energy performance (electrical losses at the input of the frequency converter power circuit) have been considered [2].

Results. In an open system, during smooth start of an asynchronous electric drive whose speed is adjusted by changing the frequency, it can be seen the smooth starting. Therefore, we can see that the frequency change time depends on the starting process and the energy performance [3].

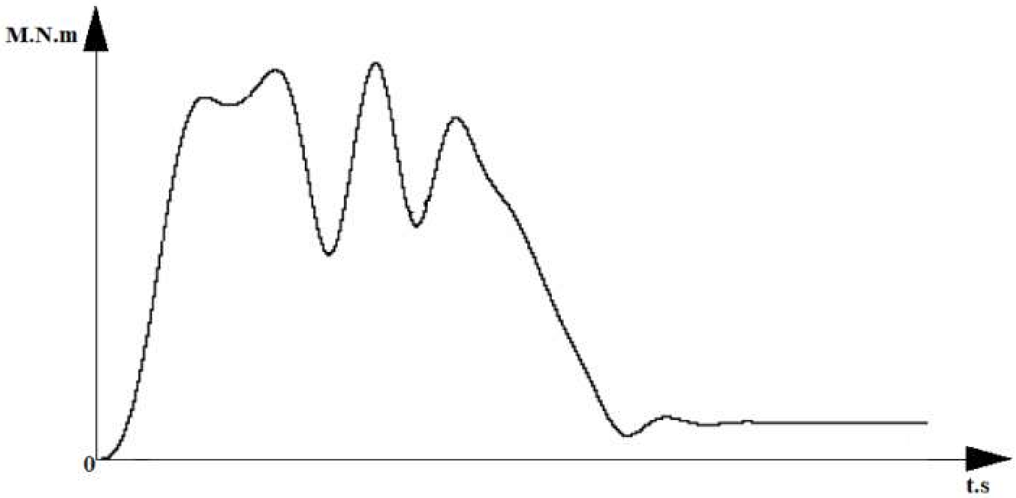

Fig. 4. Oscillogram of instantaneous values of the electromagnetic moment *M(t)* during smooth start of asynchronous motor of the feed grinding device by the frequency converter [4]**

Fig.5 shows the characteristics of the change in instantaneous values of the angular velocity $\omega_*(t)$ at the start of the control of asynchronous motors of the feed grinding

device used in agriculture by frequency converter.

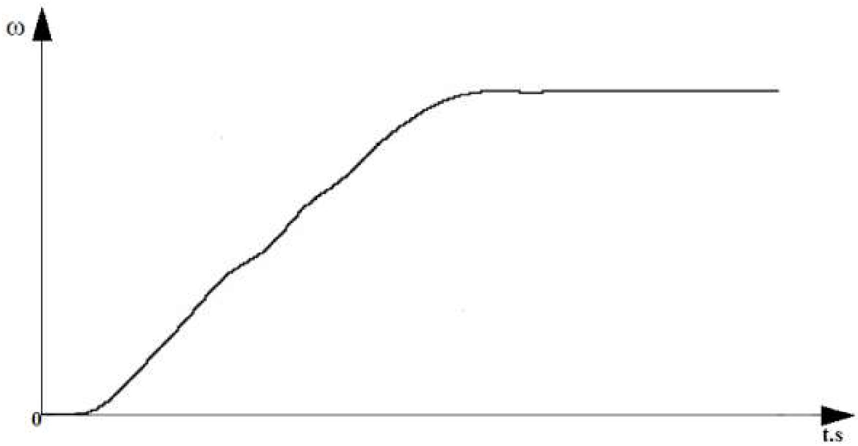

Fig. 5. Oscillogram of the smooth start of asynchronous electric drive, the speed of which is adjusted by changing the frequency of asynchronous motor of the feed grinding device [4]

For all variables of an asynchronous motor, their nominal values are taken as their base parameters, regardless of the rotor speed. The base value of the rotor speed is the ideal operating speed of the nominal frequency [4].

Discussion. Asynchronous motors of feed crushers, the speed of which is adjustable by changing the frequency, along with saving the energy in static modes, saves the energy in dynamic modes as well [1]. When starting the asynchronous motor of feed crushers without direct mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, if the inertia torque of the asynchronous motor and working mechanisms is large it lasts a very long time [5]. As a result, the stator coil insulation heats up above the allowable temperature and the insulation fails. Therefore, when starting asynchronous motors, the speed of which is controlled by a certain pattern, which prevents the stator current from overheating, and then the induction motor is started normally in the thermal mode [6-11]. It is known that large electromagnetic moments and currents occur during direct starting of asynchronous motors. Large-amplitude oscillations of electromagnetic moments can create dangerous dynamic loads in the stator winding of asynchronous motor and can cause mechanical stresses in the kinematic chains of electric drive. Therefore, in starting the asynchronous motor of feed crushers ensuring a smooth flow of stops, i.e. the prevention of the formation of large dynamic voltages prolongs the service life of the asynchronous motor.

Conclusion. As conclusion we can say that during the operation of the asynchronous electric motor of feed grinding device used in agriculture, optimal control of static and dynamic modes of the asynchronous motor was achieved, that is, saving power consumption through frequency control, adjusting the speed of the asynchronous motor, increasing the efficiency of the electric drive by smooth starting and stopping the electric drive, and reducing the power loss of the asynchronous motor were achieved.

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SYSTEMATIC ANALYSIS OF THE STATE OF CONTROL OF THE TECHNOLOGICAL PROCESSES OF UNDERGROUND LEACHING

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Abstract:

Objective. to create optimal algorithms and programs that calculate the main geo-technological indicators of the mineral mixing process, to distinguish the factors affecting the management process in mine processing.

Methods. Fourier, Laplace, Bubnov-Galyorkin's substitution and finite-difference methods of approximation are used to solve the diffusion problem of the underground leaching (UL) process.

Results. One of the geo-technological methods used in the extraction of minerals, the method of mineral mixing, was systematically analyzed and the process of extracting useful components using this method was studied. Two-dimensional mathematical control models that are suitable for this process were developed. As a result of solving these models, the dynamics of concentration changes and the values of parameters affecting the effective course of the process were analyzed using various diagrams.

Conclusions. in order to calculate the decision-making parameters when conducting a computational experiment and process control, underground leaching and their mathematical models must be compatible with natural processes and the parameters involved in it, and software tools must also be developed to visualize the calculation results corresponding to the mathematical model.

Keywords: systematic analysis, useful component elements, erosive mixing process, suction and injection wells, concentration quantity, optimization factors, mathematical models, visualization of results, management process.

Introduction. It is known that geo-technology is a science that studies geo-technological methods of extracting various minerals without direct human intervention. It collects data on various physical and chemical processes occurring underground, the formation and movement of minerals, and geo-technological processes associated with environments in mountains. Its main task is to use the action of working reagents to convert the moving rocks into useful components and extract them upward using thermal, substance exchange, chemical, diffusion and hydrodynamic processes. Among such methods, the most widely used is the underground leaching method, the essence of which is to remove the mineral as a product from its location under the influence of a chemical reagent with a specific solution. UL refers to the filtration-diffusion process and is based on a solid-liquid chemical reaction. It is mainly used in the mining of non-ferrous, rare and radioactive metals.

UL is such a complex technological process that it usually consists of filtration, diffusion and kinetics. Leaching, as a filtration process, sends the solution from one point (pouring well) to another and sends the dissolved product together with the filter solution to the suction well. The leaching process takes place in a permeable ore medium and the filtration process takes place.

In UL, ore preparation and processing is done mainly through boreholes, and most of the mining is done above ground. Therefore, semi-products that are easy to turn into final products are obtained from the ground, and they go through many processes of ore processing on the ground.

In information technologies, today, the issue of adopting solutions in complex conditions is of utmost importance. Now, mathematical methods are widely used in the analysis complex systems and representing them. If the magnitudes consisting of random quantities move according to certain laws, it is clear to achieve success in technological

processes, but the main difficulties arise when the parameters are completely uncertain, and they can significantly affect the solution. Specialists often have to work with imprecise parameters in equations or imprecise technological information. This situation is due to the lack of information about the studied object and the fact that a person is not directly involved in the management process.

The main feature of information technologies that support decision making is in qualitatively organizing human-computer interaction in a new way.

The UL process is a technological process because it is done by man. In UL, if wells were not involved, the process would take place only on the basis of natural hydrodynamic laws. However, human influence can either accelerate the process or vice versa. New information is obtained by observing and analyzing the dynamics of changes in parameters and quantities affecting the technological process. The need to create a knowledge repository containing all these changes creates the need to create a mathematical model and algorithms for decision-making in the appropriate management of the UL process.

Methods. One of the important features of the EQ process is the maintenance of the balance amount of the injected and extracted solution, which ensures the maximum (field) circulation of the solution at the boundary of the ore layer: $\sum_{i=1}^{N} q_i^H = \sum_{j=1}^{M} q_j^0$. Here, N is the number of wells into which solution is poured, the amount of productivity in the $q_i^H -$ well, M is the number of wells receiving the product, the amount of productivity in the $q_j^0 -$ well.

$\sum_{i=1}^{N} q_i^H < \sum_{j=1}^{M} q_j^0$ in this case, due to the upward movement of water from the ore-free part of the layer, the impoverishment of the technological solution is observed, and as a result, it causes the following tasks:

-permanent reduction of underground water level;

- collection of the used solution.

$\sum_{i=1}^{N} q_i^H > \sum_{j=1}^{M} q_j^0$ in this case, seepage of solution enriched with minerals is observed at the boundary of the ore layer, and it can lead to the following consequences:

-pollution of used fresh water at the border of the ore layer;

- constant increase of the level of ground water.

The EQ process is a hydrometallurgical phenomenon that occurs as a result of the interaction of subsystem elements. Therefore, in the mathematical modeling of the process, the equations of hydrodynamics, diffusion and kinetics of substance exchange are simultaneously considered.

To create a mathematical model representing the process, it is necessary to consider the following physical conditions. The UL process of metals in an ore permeable layer consists of chemical preparation consisting of saturation and mixing of the mixture. There is no significant border between them. They complement each other. On the one hand, intensive leaching occurs simultaneously during saturation of the ore layer with solution. On the other hand, increasing the reagent concentration in the saturation layer takes a long time, during which a significant part of the intensively extracted metal is extracted as a result of UL.

Therefore, by solving the UL equation of hydrodynamics, it is possible to determine the amount of product in the ore-conducting boundary layer, the nature of leaching, the consumption of product in the internal parts, the capacity of wells where the solution is pumped, the maximum amount of debit of the wells where the product is extracted, and it is possible to show how external mixing causes changes at the expense of the natural speed

of the flow in specific objects. Determining the value of the pressure at each point helps to form correct ideas about the movement of the liquid in the environment.

The problem of filtration-convective diffusion in the EQ process is expressed in the following sequence, taking into account the limit of reagent diffusion based on chemical kinetics.

Initially $G=\{(x,y,t)/\ a<x<b,\quad c<y<d,\quad 0<t\le T_k\}$ to determine the filtration flow characteristic in a confined area: $(x,y)\in G$ $H(x,y,0)=H_0(x,y)$, primary: $(\theta\frac{\partial H}{\partial n}+(1-\theta)H)/_{\Theta}=\varphi(x,y)$, θ ={0 ёки 1} satisfying the boundary conditions are used (here Si –closed contour, h – height):

$$mh\beta\frac{\partial H}{\partial t}=\frac{\partial}{\partial x}\left(\frac{kh}{\mu}\frac{\partial H}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{kh}{\mu}\frac{\partial H}{\partial y}\right)+f(x,y,t)$$

$$f(x,y,t)=\frac{\mu}{k}\sum_{i=1}^{N}\delta(x-x_i,y-y_i)q_i(t)$$

The filtration rate is determined by Darcy's law:

$$v_x=-k\frac{\partial H}{\partial x},\qquad v_y=-k\frac{\partial H}{\partial y}$$

Distribution of useful component concentration $C(x,y,0)=C_0$ - initial and $(\alpha\frac{\partial C}{\partial n}+(1-\alpha)C)\Big|_{\Theta}=\omega(x,y,t)$ - boundary and

$$C(x,y,t)\big|_{(x,y)=(x_i,y_i)}=C_i,\qquad \frac{\partial C}{\partial n}\Big|_{(x,y)=(x_j,y_j)}=0$$

satisfying internal conditions is determined by UL:

$$m\frac{\partial C}{\partial t}=\frac{\partial}{\partial x}\left(D\frac{\partial C}{\partial x}\right)+\frac{\partial}{\partial y}\left(D\frac{\partial C}{\partial y}\right)-\frac{\partial(v_xC)}{\partial x}-\frac{\partial(v_yC)}{\partial y}-\frac{\partial N}{\partial t}\qquad(1)$$

Results. Figure-1 shows the isolines corresponding to the results. The analysis of the obtained results shows that the models proposed for decision-making in the control of technological processes of IL correspond to the physical properties of the process and can be used in the process of controlling them and in data processing.

There is a need to use numerical-approximate methods for solving the problem, since analytical solutions are formed only in special cases with certain restrictions. The reliability and stability of the results is verified by a computational experiment based on the trial function method.

For a task

$$D\frac{\partial^2 C}{\partial x^2}-U\frac{\partial C}{\partial x}-f(x,t)=m\frac{\partial C}{\partial t},\quad C\big|_{t=0}=1,\quad C\big|_{x=0}=1,\quad C\big|_{x=1}=1\qquad(2)$$

the results are obtained using a numerical-approximate method using finite-difference schemes.

To verify the reliability of the developed algorithms and software, the compliance of the calculation results with the specified mechanical and physical properties is given. Figure 2 shows the concentration distribution of the useful component at different time points for the case of single-injection x = 450 m and single-pump x = 400 m wells.

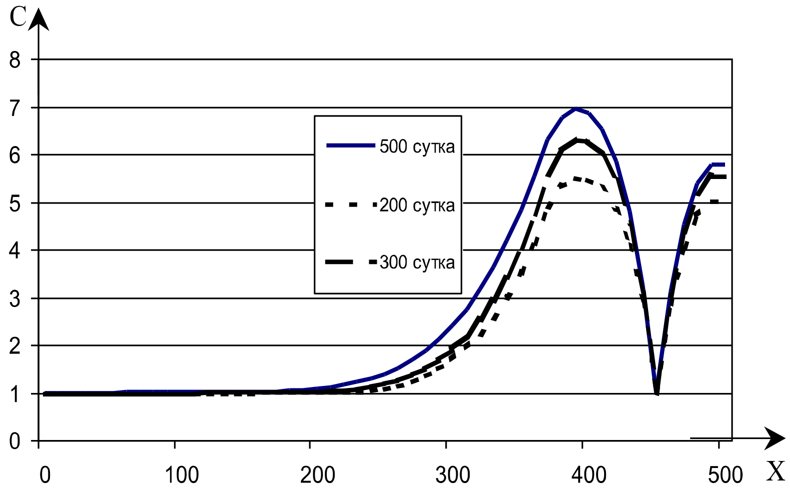

Figure 1. Linear concentration value

So, in order to make the necessary decisions in order to control the technological process of UL, the following tasks are solved:

- systematic study of the UL facility;
- creating a database for decision making and describing how it can be used.

Discussion. Here, several specific decision-making problems for the appropriate control of the UL process are considered and the influence of several parameters on the change in concentration is studied. Below are some of them.

In the case when there are four injection wells and one extraction well located at the point (5, 5), the results are obtained for different flow rates in the extraction well. The calculation results were analyzed for T = 91; 200 days.

The results of the analysis for 91 days are shown in Fig. 8, which shows a graph of the relationship between the flow rate in the extraction well and the concentration value at points (10.10) and (10.20).

From the results obtained, it can be concluded that the concentration value at points located further from the injection well increases faster than at points located close to the injection well. The reason for this is the increase in the flow rate in the extraction well.

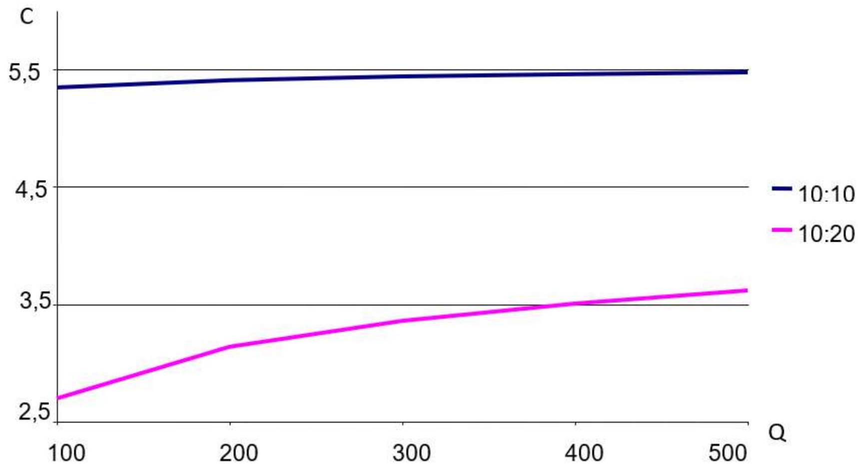

Figure 2. Computational values of concentration change for different production rates over time

It is required to control the UL process in such a way that after 360 days the average concentration of the useful component in the pumping wells reaches a maximum (i.e. Cav = 9.4 mg/m) by selecting criteria for the acid concentration in the injected reagent. To solve the problem from real factors, the limits of changing the acid concentration (γ) in the injected solution were determined. In our data, the dimensionless value of this parameter (γ) is determined within 0.05.10-7 < γ < 0.5.10-7.

Conclusion. Thus, the UL process is as human-made process as it is based on technology. In UL, if wells were not involved, the process would take place only on the basis of natural hydrodynamic laws. But, human influence can either accelerates the process or vice versa. New information is obtained by observing and analyzing the dynamics of changes in parameters and arguments affecting the technological process. The need to create a repository of knowledge that holds all these changes is realized by the appropriate management of the technological process of UL.

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ANALYSIS IN SOLIDWORKS SOFTWARE OF THE STRENGTHS GENERATED IN THE UNDERGROUND PART OF THE WAGONS AS A RESULT OF THE IMPACT OF FORCE ON THE ENTIRE WHEELS OF WAGONS

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Abstract:

Objective. The purpose In this article, the vertical and horizontal forces acting on the wheel of a freight car are calculated using formulas, and the calculated forces are determined by placing the wheel on a 3D model using Solidworks software.

Methods. The 3D model of the wheel is drawn using the Solidworks program according to GOST 10791-2011, and the forces calculated through the simulation section are placed on the rolling surface, and the results are tabulated.

Results. When the calculated forces were applied to the wheel through the simulation section of the SolidWorks program, the minimum stress on the bottom part of it was 10 MPa, and the maximum stress was 120 MPa. The stress results were calculated 60 times, that is, the forces were divided into 12 blocks and the wheel was turned five times. Efforts were made after each direction and results were obtained

Summary. The conclusion of the scientific article is that the tension generated in the wheel is related to the thickness of the tread. When the wall thickness was 70 mm, when the operational maximum force was applied to it, a stress of 80 MPa was generated. During the service life, the value of voltages in the calculation field changes in each direction

Keywords. Rolling surface, polzun, uneven rolling, wheel, solidworks, simulation, prosperity, computational area, mises stress.

Introduction. Pairs of wheels are considered the main part of the movement structure, and its durability and reliability are considered the most important issues when the wagon appears. Many scientists have worked on evaluating, analyzing and increasing the durability of the wheel [1,5,9]. The wheel is affected by vertical and horizontal forces (Fig. 1), and these forces are divided into static and dynamic types. When finding these forces, the loaded or unloaded state of the wagon is taken into account □2,3,7,14□. The following calculation diagram shows the cross section of the wheel and the direction of the forces falling on the rotating surface and its linear dimensions [4,8,11]. As we all know that there are many types of drivetrain wheel disc, in this work we will only do the calculations by putting the force values according to the calculation diagram below for flat disc all-round wheel. The

value of the forces was calculated using the formulas in table 1 given in the norm.

Methods of scientific research. The 3D model of the wheel is drawn in the solidworks program according to GOST 10791-2011 [17], the forces calculated according to the norm are placed on the rolling surface through the simulation section, and the stress level is determined. Determined forces are applied to the minimum thickness of the rim after each direction of the rim [6,10,13].

According to current calculations, the entire rolling wheel rotates five times during its service life. By applying forces calculated on the rolling surface of the pavement after each direction, the stresses generated in the subgrade part of the pavement are transferred and placed according to the columns in Table 2.

This method was implemented using software. There is also a methodology for theoretically calculating the same voltages, and we will cover this in our next scientific articles.

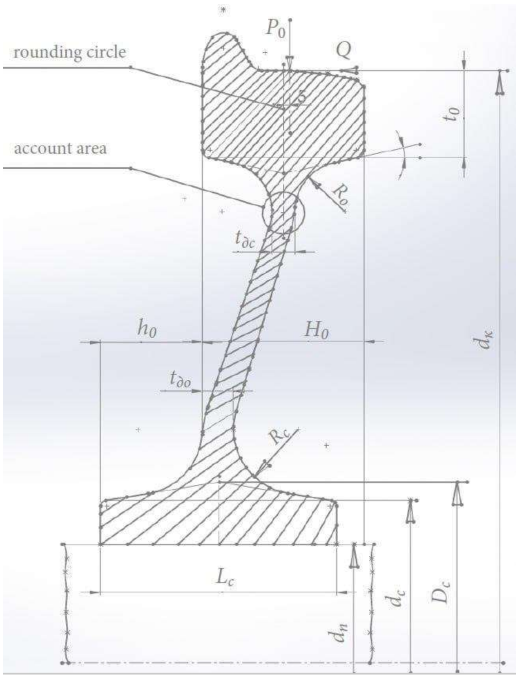

Figure 1. Standard and design wheel view

This drawing shows the vertical P and horizontal Q forces on the wheel, its linear dimensions and the calculation zone. The forces acting on the wheel vary in different values depending on the defects of its rolling surface. When we find the forces, we consider 3 types of failure states of the wheel rolling surface: non-defective, slippery and uneven rolling. The value of the forces acting on this failure is calculated using the formulas given in Table 1 below [12,15].

Table 1

The condition of the washing surface	Formulas for determination Mean square approximation	 Mean square approximation
	Vertical force	
Defect free	$\overline{P}_1=0{,}621\cdot P$	
Polzun	$\overline{P}_2=0{,}856\cdot P$	
Uneven rolling	$\overline{P}_3=0{,}533+14{,}252\cdot 10^2\cdot v\cdot m^{1/2}$	$\overline{P}_{p3}=5{,}915\cdot 10^2\cdot v\cdot m^{1/2}$

	Horizontal force	
In any case	Q=3,78·10^{-3}υ·P	S_{Qj}= 2,457·10^{-3}υ·P

* Note: vertical forces acting from the wheel to the rail in a static state, kN
P=Po=230.5 in the loaded state, P=Pn=60 in the unloaded state
mn = 1797 kg – the total weight of the lower parts of the spring acting on the wheel
y = 25 m/s (90 km/(h)) – calculated speed.

When we calculate the forces acting on the wheel, we consider the weight of the axle as 23.5 tons [13,18]. In addition, formulas for root mean square approximation are also presented in this table. The mean square approximation means that we can find a limited amount of variation of the calculated forces, that is, the value of the determined forces is observed in the range of values found by this approximation. We do not calculate the root mean square approximation in this work, but instead calculate the value of the vertical and horizontal forces acting on the wheel by mathematical expectation. Below, we will only do the calculations for the wheels of the freight cars, since the structural speed and the mass of the lower parts of the springs will be needed.

The values of the vertical and horizontal forces acting from the wheel to the rail were calculated using the formulas given in the table for loaded and unloaded wagons [14,20].

These calculated forces were applied to the rolling surface of the wheel drawn according to GOST 10791-2011 in Solidworks using the simulation section (Fig. 2) and stress values in the calculated zone were obtained.

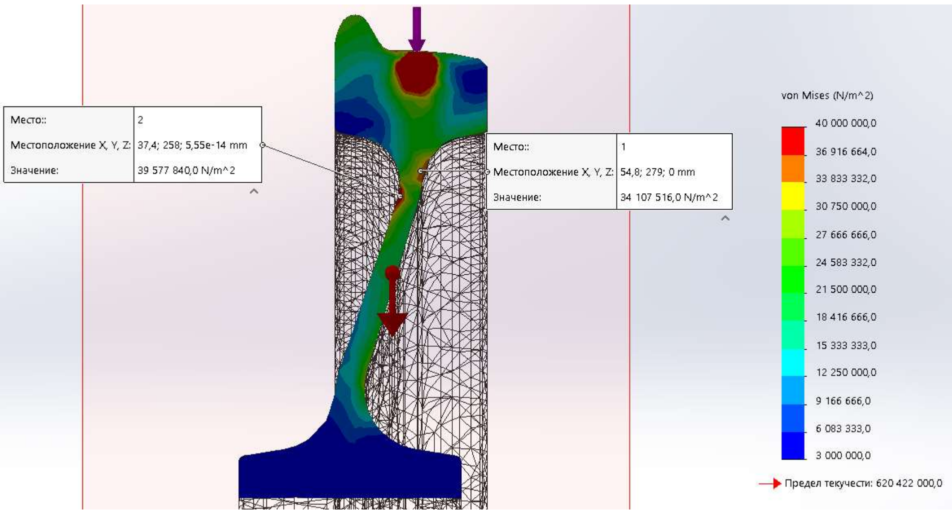

Figure 2. Image of the force applied to the wheel and the stresses in the calculation zone in the Solidworks/simulation program

Calculated forces were applied to the new wheel, resulting in the following image (Figure 2). The results have been moved to column 1 of the table below. On the rest of the columns, the forces calculated after each direction were placed, and the results were copied in sequence. Depending on the types and sizes of faults, the thickness of the rolling stock wheel is changed 5 times during the average service life [15,19]. After each direction, the value of the voltage in the calculation zone increases.

Results. When the calculated forces were applied to the wheel through the simulation section of the SolidWorks

program, the minimum stress on the bottom part of it was 10 MPa, and the maximum stress was 120 MPa. The stress results were calculated 60 times, that is, the forces were divided into 12 blocks and the wheel was turned five times. Efforts were made after each direction and results were obtained. From Figure 2 above, we can see that when a force is applied to the rolling surface of the wheel, its high stress areas are represented by red colors.

The obtained results were found to be positive according to the requirements given in the regulatory documents, and we have observed in our previous scientific works that the accuracy level is higher than 95% when the results are obtained by influencing the detail with the help of software [7,11,16].

Table 2

Block number of forces j	Wagon condition	Impact force, kN	Action share λ	The average Mises stress in the calculation area of the wheel is MPa when it is oriented n times				
				n=0	n=1	n=2	n=3	n=4
1		$\overline{P}_1$=142,8	0,2514	45	50	55	57	60
2	Loaded	$\overline{P}_2$=196,9	0,045	55	60	65	72	77
3		$\overline{P}_3$=273,8	0,0036	75	85	90	100	110
4		$\overline{P}_1$=37,3	0,1676	10	11	12	15	16
5	Not downloaded	$\overline{P}_2$=51,4	0,03	15	18	19	21	22
6		$\overline{P}_3$=182,7	0,0024	50	55	60	70	75
7		$\overline{P}_1$=142,8 Q=21,7	0,2514	48	53	60	64	69
8	Loaded	$\overline{P}_2$=196,9 Q=21,7	0,045	60	70	78	82	92
9		$\overline{P}_3$=273,8 Q=21,7	0,0036	80	90	100	110	120
10		$\overline{P}_1$=37,3 Q=5,67	0,1676	10	12	15	17	18
11	Not downloaded	$\overline{P}_2$=51,4 Q=5,67	0,03	15	19	21	22	24
12		$\overline{P}_3$=182,7 Q=5,67	0,0024	55	60	67	73	76

Note: $\overline{P}_1$ – for a defect-free condition of the wheel rolling surface; $\overline{P}_2$ – for wheel slip position; $\overline{P}_3$ – for the condition of uneven rolling of the wheel surface.

The Mises stress in the calculation area was obtained as a result of applying the forces when the wheel is directed to the minimum limit according to GOST and the change of forces.

Conclusion. as a general conclusion, these values increased due to the reduction of the thickness of the wheel part as a result of turning, and the highest value was observed when the wheel was loaded and rolled unevenly. The highest stress value was 120 MPa when calculated according to the Mises stress.

It should also be mentioned that the greatest tension was created after applying a horizontal force of 21.7 kN and a vertical force of 273.8 kN in 9 power blocks after the fifth direction. vertical was formed by applying a force of 37.3 kN and its value was 10 MPa.

These conclusions were given on the basis of the results obtained using the solidworks program of the stresses generated in the lower part of the wheels as a result of operational forces. In our next scientific articles, we will continue the comparison with the results obtained by theoretical calculation and software calculation.

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THE PROCESSES OF GRADUAL MODERNIZATION OF THE STATE ADMINISTRATION SYSTEM IN UZBEKISTAN OVER THE YEARS OF INDEPENDENCE

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Abstract: The article states about the reorganization of the new system of public administration in independent Uzbekistan, the gradual improvement of the activities of the legislative, executive and judicial authorities, the strengthening of the norms that ensure their independence and equality and mutual restraint. Analyzed the reforms carried out on the way to the formation of a democratic civil society, their goals and practical results.

Keywords: public administration, local government, election, E-government, public service.

Introduction. During the years of independence, Uzbekistan has been systematically implementing reforms aimed at democratizing the system of state power and administration, ensuring the rule of law and forming a free civil society. It is important that public administration be organized on the basis of democratic principles in order to stabilize the economic development in the country, reduce poverty, effectively use human resources and scientific and technological achievements, as well as effectively solve the problems facing the state and society, as well as worthy protection of human rights, interests of the state and people. Therefore, the study of the public administration system and the principles of its functioning, the study of the results of the reforms carried out is one of the topical issues of today.

Methods. This topic is widely studied by political scientists, lawyers, philosophers, sociologists and historians. They are reflected in the stages of formation and development of public administration in Uzbekistan, the activities of political institutions, modern management and leadership training. In particular, M. Mullajonova in her dissertation researched the role and importance of socio-political institutions in the formation and development of a democratic society in Uzbekistan, the lower structures of state power, the structure and tasks of citizens' self-government bodies in building a democratic society, and the impact of increasing the political activity of citizens on democratic processes [7]. O. Jumaev researched the features of the development of national statehood in Uzbekistan and analyzed the essence, main trends and tools of the development of national statehood. The concept of national statehood, its political content, emphasizing its place in the development of society, has developed a methodology for determining indicators of the characteristics of national statehood by studying the patterns of historical development of statehood [3]. M. Boydadaev also studied the formation of a system of state building and management in Uzbekistan, the organization of management institutions, new forms, methods, legal foundations, the state of organizational structures and the processes of reforming the functional status of public authorities and management in the processes of liberalization of management [2].

Results. After Uzbekistan gained independence, the task of building a democratic and legal state corresponding to world leaders was included on the agenda, and the creation of a civil society as the first and most important issue. The country carried out multi-sectorial reforms in the socio-economic and political spheres, the main task was to strengthen

the rule of law, ensure the rights and freedoms of citizens. The reason was that public administration, socio-economic and international relations inherent in the socialist system did not correspond to the interests of the new state. The administrative-command, planning-distribution system was abandoned; the "Uzbek model", consisting of five principles was developed. That is, state building and the constitutional system were renewed, the economy was driven by ideology, ensuring its supremacy over politics, turning the state into a reform initiator, ensuring the rule of law, maintaining a strong social policy, and gradually implementing reforms were in the focus. The powers of the newly formed state and local authorities, the legal basis for determining their activities, began to be created.

Particular attention was paid to historical experience, national traditions and values when establishing a new public administration in the country, the experience of developed foreign countries was studied and measures were taken to put into practice in the "Oriental" style, without copying. The powers of the governing bodies during the existence of the Soviet Union were considered and redistributed, the powers of which were mixed with each other, which did not fully fulfill their functions, and a system was formed that provided for mutual control over each other.

Since the last years of the government of the Soviet Union in Uzbekistan, work began on the formation of this system. On March 24, 1990, the post of president was introduced in the Uzbek SSR, the first among the republics within the USSR [29]. The system of state administration was transferred from a collegiate body - the Presidium of the Supreme Soviet of the Uzbek SSR to the Presidential Institute, which manages the system of state power in the person of the sole leader. Initially, according to Article 89 of the Constitution of the Republic of Uzbekistan, "the President of the Republic of Uzbekistan is the head of state and executive power in the Republic. It was determined that, at the same time, he is the chairman of the Cabinet of Ministers" [10, p.39]. As a result of the reforms, the gradual elimination of existing problems in public administration, the regulation of the activities of state bodies, the increase in the legal culture and political consciousness of the population gave rise to the possibility of transferring part of the presidential powers to other authorities. Therefore, in 2003, the rule on the appointment of the President of the Republic of Uzbekistan as the Chairman of the Cabinet of Ministers was excluded [30]. This was another step towards ensuring that power in the country was divided on the basis of equal representation.

The president has the right to initiate legislation, and a system has been established whereby he will sign laws passed by parliament or return them to parliament (veto) when objections arise. In the event of unresolvable disputes within or between the chambers, or in the case of repeated adoption by the chambers of decisions that contradict the Constitution of the Republic of Uzbekistan, the powers to dissolve the chambers of the Oliy Majlis are given in agreement with the Constitutional Court of the Republic of Uzbekistan. The president also gained the authority to nominate candidates for the positions of the Constitutional Court, chairmen and judges of the Supreme Court, appoint or dismiss chairmen of the regional court, approve or dismiss the composition of the government and the prime minister.

The consolidation of these powers in the Constitution of the Republic of Uzbekistan, ensuring its effective functioning as the head of state, mutually agreed authorities and strengthening their cooperation have become a legal basis.

In the course of the reforms, along with the presidential institution, over the

years, the activities of the executive branch have been improved. These actions were initially carried out from the beginning of 1990 and were called the Cabinet of Ministers of the Government of the USSR of Uzbekistan[29]. On November 1, 1990, the executive and administrative power of the Council of Ministers of the USSR of Uzbekistan was merged with the presidential power of the Uzbek SSR and transformed into the Cabinet of Ministers under the President of the Uzbek SSR. The president and the government were united, and the president at the same time remained as a chairman of the Cabinet of Ministers.

To manage the Cabinet of Ministers and organize its activities, the post of Vice President was established. However, by the law of 4 January 1992, this position was abolished and replaced by the Prime Minister [25]. And also, in the regions, districts and cities of the Republic, the position of hakim was established, headed by representative and executive-administrative authorities, as well as the official representative of the President of the Republic of Uzbekistan in the areas [31]. Article 103 of the Constitution provides that hakims may carry out their activities on the basis of sole leadership and are personally responsible for their activities and decrees. The development of territories, the elimination of existing problems and the creation of suitable conditions for the life of the population were assigned to the hakims. In order to organize the activities of hakims, establish their powers and coordinate their interaction with local councils of people's deputies, the law "On Local State Power" was adopted. It determines the interaction of local representative and executive authorities, as well as relations with other organizations and departments, documents adopted by them, the procedure for the formation of structural units, forms of ownership, the local budget, the formation and spending of extra budgetary funds[20].

In 1993, the Cabinet of Ministers received the status of an independent body [23], and since then the number of ministries and departments has been gradually reduced. Some ministries were reorganized, some merged, others liquidated, in their place there were economic associations, associations and corporations that quickly adapted to market relations. As a result, the direct intervention of the state in economic activity was reduced, and the degree of freedom of enterprises and organizations was expanded.

The reform of the Republic of Uzbekistan on the role of the government in solving socio-economic issues in the country, as well as the abolition of the powers of the President of the Republic of Uzbekistan to simultaneously head the Cabinet of Ministers [30] necessitated the development of a law of the Republic of Uzbekistan "On the Cabinet of Ministers"

As a result of the adoption of the laws "On the Cabinet of Ministers of the Republic of Uzbekistan"[24] and "On the renewal and further democratization of public administration and the role of political parties in the modernization of the country" in a new edition, the post of Chairman of the Cabinet of Ministers was completed. The leadership of the Cabinet of Ministers, the effective organization of its activities, the high-quality and timely execution of orders of the Cabinet of Ministers were assigned to the Prime Minister as the main task. The number of administrative and managerial personnel in the executive authorities was reduced to more than 40 thousand staff units or 22 percent [9, p.57].

Article 89 of the Constitution of the Republic of Uzbekistan was changed to "The President of the Republic of Uzbekistan is the head of State and ensures the coordinated activity and cooperation of state authorities"[11,

Ch.24], and the proposal was deleted from paragraph 8 of Article 93 that the President "establishes the executive power apparatus and heads it" [12, Ch.43, 46].

In 2011, a new practice of forming the structure of executive power was introduced in Uzbekistan[9, p.57]. A system has been introduced to present the candidacy of the prime minister to the Legislative Chamber of the Oliy Majlis by one political party with the largest number of deputies or by several political parties with an equal number of deputies. This system further strengthened the principle of a democratic state in the country, symbolizing the attachment of the executive branch to a political party.

Also, in accordance with paragraph 15 of Article 93 of the Constitution, the Prime Minister is granted the right to present to the President of the Republic of Uzbekistan the hakims of the regions and the hakim of the city of Tashkent their candidacies for appointment or dismissal [26]. On the one hand, this expanded the powers of the prime minister, and on the other hand, increased the responsibility of the prime minister for the socio-economic development of the regions.

These actions, aimed at reforming the executive branch, served to improve the work of the Cabinet of Ministers, forming it as an independent institution from the institution of the president, and turning it into a body fully responsible for the effective implementation of reforms. This increased the responsibility for the socio-economic development of the regions, ensuring a comfortable life for the population, the development of all sectors and sectors in the spirit of the times, and the Cabinet of Ministers was given independence in the implementation of these works.

In this regard, it should be noted that the improvement of the activities of the government with the presidential institution in the country, in turn, required reforming the activities of the legislative and judicial authorities.

The development of the activities of the Oliy Majlis, acting as the legislative power in Uzbekistan, has become a priority direction of state policy. The reason is that the parliament is an institution that legally regulates the activities of a person, society and the state in the country. The Oliy Majlis of the Republic of Uzbekistan went through certain stages of development before the advent of the bicameral system. These development processes can be divided into 3 stages.

At the 1st stage (1990-1994), the Parliament of Uzbekistan was called the Supreme Council and was formed according to the results of the elections held in February-March 1990, the last years of the existence of the USSR society. In the formation of Uzbekistan as a sovereign state, in the first application of democratic principles, in the formation of the Uzbek national statehood, the activities of the Supreme Council of the Republic of Uzbekistan of the XII convocation are of historical importance. Unlike previous elections, the Central Electoral Commission was established as a permanent working body for a period of five years. The circle of subjects having the right to nominate candidates for deputies has been expanded, even in the case of one party. Basically, various trade unions and public organizations began to nominate candidates, several candidates were allowed in constituencies for one mandate. For the first time, the term of office of higher and local government bodies was equalized [5, 63-64].

At the 2nd stage (1995-2004), the parliament was called the Oliy Majlis, and during this period the Oliy Majlis was convened twice (1995-1999; 2000-2004). The difference between the newly formed Oliy Majlis and the Oliy Kengash was that the Oliy Kengash was formed on the basis of a social class approach. That is, quotas were established for workers, collective

farmers, intellectuals, youth, women, etc., and they were elected according to these quotas. Only communists and non-party people took part in the elections, while taking into account the territorial principle. In the case of candidates for deputies of the Oliy Majlis, the main criterion is the presence of diligence, moral qualities, social and political activity. Elections were held on the principles of a multi-party system, and for the first time factions and blocs were formed within the parliament [5,.63-64].

It should be noted that in Uzbekistan, which has chosen an evolutionary path of development, the processes of reforming the parliament were carried out in stages. At a time when the legal foundations of a democratic civil society were just being created, a unicameral form of parliament was approved. Because a unicameral parliament was an acceptable choice for a new country where the rule of law is felt in all areas of the state and society. In this form of parliament, the legislative process is faster, has a mobile and compact form. However, the unicameral Oliy Majlis was not a permanent body and functioned only during sessions. All deputies did not work continuously professionally. The reason is that certain conditions were required for the work of all deputies on a permanent basis. This did not allow them to fully exercise their powers and responsibilities.

During the transitional period, in the conditions of reforming public life, at a time when democratic institutions were not developed, and professional politicians were not yet sufficiently formed, deputies of the Oliy Majlis continued their labor activity in the relevant sectors of the national economy. Perhaps this was a convenient solution for a young country that needed to solve economic problems. This has its positive aspects, firstly, the potential and practical experience of the personnel are effectively used. Secondly, the activities of the deputies, directly related to practice, served to adopt the necessary laws in all areas. The deputies are part of them and provide a connection between the people and the state, practice and theory in management.

Stage 3 (period after 2005). From this period, the Oliy Majlis began to function as part of two chambers - the Legislative Chamber and the Senate[8]. Professional activity in the parliament was carried out by 150 deputies of the Legislative Chamber, elected on the basis of a multi-party system in the regional districts. A mechanism was introduced in which draft laws are considered in the Legislative Chamber from their initial state to completion, and bills adopted by the majority of deputies are sent to the Senate for approval [27].

The Senate, considered the regional representative chamber, consists of one hundred members of the Senate (senators), 84 of which are formed by electing six people from among the deputies of the regional representative bodies. The remaining 16 people are appointed directly by the President of the Republic of Uzbekistan from among distinguished citizens who have earned high merits in the field of science, art, literature and production, as well as in other areas of state and public life and having extensive life and professional experience [28].

The Senate considers and approves laws passed by the Legislative Assembly or returns them to the Legislative Assembly for reconsideration. If the law is approved by the Senate, it is sent to the President of the Republic of Uzbekistan for approval within ten days.

"Why did the transition to a bicameral parliament take place?" - the right question arises. In a two-chamber system (bicameralism) [1, Ch. 207], the parliament usually consists of two chambers, which are formed in different ways and have different powers, and the parliament is not only a legislative, but also a representative body. The second chamber, formed quite differently, causes the other chamber to be

contained. That is, the "control" chamber helps to correct the mistakes and hasty decisions of the first chamber, make effective decisions taking into account the interests of the regions, and stabilize the balance between parliament and government in the field of public administration.

In recent years, gradual reforms have been implemented in the country aimed at ensuring that the judiciary functions on the basis of independent principles, in order to transform it from a punishing body into a body that protects the rights and interests of citizens. Measures were taken to ensure the true independence of the court and judges from all other branches, subordination only to the law when making judicial decisions. The adoption of the Law of the Republic of Uzbekistan "On Courts" on September 2, 1993 was one of the first steps towards the independence of the judiciary in the country [21]. This law is the basis for judicial reform in the country and establishes universally recognized principles such as the presumption of innocence, the right to a defense, polemic and transparency of the judicial process. The Constitutional Court was created for the first time. The economic courts were created to provide legislation in economic relations in the context of the transition to a market economy.

In 1994, the Criminal Code [32], the adoption of a program for the further development of judicial reform by the decision of the Council of the Oliy Majlis in 1996[13] and the establishment of the Judicial Association of Uzbekistan in 1997[33, Ch 64] served as an important factor in the restoration of the judicial system. They reflected the issues of strengthening the protection of the rights and interests of citizens by the courts, democratization of the judicial system and raising its status.

In 2000, the adoption of a new edition of the Law "On Courts"[22] brought the development of the judiciary to a new stage. This law created specialized courts in the country, i.e. independent civil and criminal courts. A mechanism has also been created for the formation of an independent judiciary and ensuring the rights of citizens to judicial protection. Citizens have the opportunity to protect their rights by filing an appeal or cassation against a court decision. For example, in 2000, almost half of court errors were taken into account in the control procedure, and appropriate corrections were made to court decisions. In 2009, more than 85 percent of judicial errors were reviewed on appeal and cassation, and the violated rights of entrepreneurs and citizens were restored [4].

From January 1, 2008, the right to authorize detention in Uzbekistan passed to the courts [14]. This order strengthened the role of the judiciary in legal proceedings. Because earlier the investigating authorities applied to the prosecutor with a request to authorize the detention of a person suspected or accused of committing a crime. The prosecutor gave a legal assessment of the actions of the detainee and made a decision on authorizing the detention. In some cases, mistakes were made. Currently, the issue of authorizing detention is being considered in an open court session with the participation of the investigator, prosecutor, the accused (suspect) and his defense counsel.

Also in 2008, the Research Center for Democratization and Liberalization of Judicial Legislation and Ensuring the Independence of the Judiciary was established under the Supreme Court of the Republic of Uzbekistan. This Center was entrusted with a number of tasks, such as developing measures to improve the efficiency of the judicial system, preparing proposals for further improving the judicial system, and deepening cooperation with international and foreign organizations in this area [15].

In 2008, as a logical continuation of the process of liberalization of the judicial system, measures were developed to further reform the legal profession in Uzbekistan, i.e., the requirements for the qualifications of candidates for the position of a lawyer were strengthened, regular improvement of their professional qualifications became mandatory, the Chamber of Lawyers of the Republic of Uzbekistan and its territorial structures [17].

In 2017, the High Qualification Commission for the Selection and Recommendation of Judges was liquidated and the High Council of Judges was created, which serves to further strengthen the independence of the judiciary, effectively organize its activities and fully ensure its constitutional powers. The Supreme and High Economic Courts were merged into the Supreme Court, and it became the single supreme body of civil, criminal, administrative and economic courts. The powers of the military courts were reduced and transferred from the armed forces to the Supreme Court system. Economic courts were transformed into economic courts, 71 inter-district and district (city) economic courts were formed, empowered to consider court cases at first instance [16]. The requirement for these reforms was that, first of all, the Commission for the Selection and Recommendation of Judges acted on a voluntary basis, its special legal status was not determined, and its powers were limited. There were many factors that led to the uniformity of judicial practice and the wanderings of citizens and entrepreneurs. Also, the inclusion of military courts in the Armed Forces of the Republic of Uzbekistan was recognized as inconsistent with the principle of judicial independence. All these reforms were aimed at ensuring the independence of the judiciary, improving the functioning of the courts in the administration of justice, and shaping citizens' views on the judiciary as a body that protects their interests.

Starting from the last quarter of 2016, efforts to create a New Uzbekistan brought to a new stage the formation of a public administration system in the country based on democratic principles. In particular, the first direction of the "strategy of action" for the development of Uzbekistan for 2017-2021 is aimed at improving the construction of the state and society in Uzbekistan, which is aimed at deepening democratic reforms and further strengthening the role of parliament and political parties in modernizing the country, reforming the public administration system, development, priorities have been identified, such as the role of civil society institutions and the media [18].

Measures have been identified to increase the role of the Oliy Majlis in the domestic and foreign policy of the country, to strengthen control over the activities of the executive branch. The office of the permanent representative of the Cabinet of Ministers has been established in the chambers of the Oliy Majlis. The composition of the Cabinet of Ministers was approved by the Oliy Majlis, and the heads of regional, district and city state bodies - by the relevant Councils of People's Deputies. The existing approach and methods of work on the organization of management by executive authorities have been revised. Innovative methods were introduced and measures were taken to increase the autonomy of leaders to achieve concrete results. The organizational structure of the government has been updated. The concept of administrative reforms was approved by the President of the Republic of Uzbekistan in order to form a new, efficient and high-quality public administration system.

Of course, in any period and in any country, the potential and level of competence of the leadership team are of great importance in the effective implementation of strategic reforms and priority tasks. There is always a high demand for a team of dedicated personnel

who understand the fundamental nature of reforms and responsibly carry out the tasks assigned to them in order to fully implement the reforms and achieve the expected positive results.

In this regard, in his address to the Oliy Majlis, the President of the Republic of Uzbekistan Sh.M. Mirziyoyev set a number of tasks for all official leaders to “Optimize and improve the activities of the Government and its ministries and departments”. , increase work efficiency, strengthen personal responsibility and accountability of the management team” [6].

Discussions. To train, improve qualifications and create a reserve of educated, selfless leaders who are able to deeply analyze every change and reform in social and political life, who think in a new way, are mature, enterprising, meet the interests of the state and society and are not indifferent to the future of the country, what is going does not always lose its relevance. As a result of the political outlook and culture of the population, the demands placed on leaders have increased. This increased the need to create a new system for the selection, retraining and advanced training of potential leaders in accordance with the requirements of a democratic state based on the rule of law, the transfer of knowledge based on modern technologies and methods, and the recommendation of suitable positions. Therefore, improving the knowledge and skills of leaders and managerial personnel in all areas in accordance with modern students, reforming the activities of political institutions and related public associations, the direction and methods of training personnel has become one of the important priorities of the country's policy.

In conclusion, it can be noted that after Uzbekistan gained independence, state and non-state institutions based on democratic and legal requirements were created in the system of state power and administration. A special school for training, retraining and advanced training of heads of state administration bodies was created, and much attention was paid to the development of a new system for training management personnel. Political institutions and the system of personnel training characteristic of the socialist system were abolished. Instead of a party approach in the training of leading cadres, the question of training cadres with new thinking has become the main criterion.

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ECONOMICAL SCIENCES

UDK 338.12

FOURTH INDUSTRIAL REVOLUTION IN THE TEXTILE AND GARMENT MANUFACTURING

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Objective. This article is devoted to an overview of the current state, problems and prospects for the development of domestic textile and garment manufacturing, means and methods of process automation using the fourth industrial revolution (Industry 4.0). The necessity of introducing new technologies, computerization and automation of production, the use of machine learning technologies and artificial intelligence is substantiated.

Methods. The analysis is based on a recent research by Asian Development Bank (ADB), Leveraging the Fourth Industrial Revolution through Skill Development in High-Growing Industries in Central and West Asia. The research methodology is based on general scientific approaches of data mining, grouping and comparison, information visualization. The fundamentals of information theory, the theory and methods of solving optimization problems, the theory and technologies for the use of intelligent systems, databases and programming are used.

Results. By 2025, the desire to introduce 4IR technologies in various fields of activity will be a priority for companies, including textile and light industry enterprises. Textile and apparel companies estimate that the adoption of 4IR technologies will increase labor productivity by 68% in the long run. The study estimates that the introduction of 4IR technologies in the textile and clothing industry will create a net increase in jobs by introducing 4IR technologies through movement and productivity. The number of new jobs created by increased productivity through the introduction of 4IR technologies will exceed the number of jobs displaced by automation. It is expected that more jobs will be created as a result of the introduction of 4IR technologies - 100,000 new jobs in the textile and clothing industry of Uzbekistan and 334,000 new jobs in the construction industry. This goes beyond the usual job growth in a non-4IR scenario, which means these jobs.

Conclusion. More collaboration is needed with industry and academia about future skills needs. Communication technology (ICT) skills, creative thinking, design skills will be the most valuable skills by 2025 and it is essential that educational institutions are equipped to prepare workers for these skill changes. In the survey data, about 60% of the surveyed enterprises are trying to implement IoT technologies, but only 30% of educational institutions offer IoT-related courses. Collaboration with industries and higher education institutions can help alleviate potential resource constraints faced by institutions (such as lack of equipment or qualified instructors), while ensuring that training programs are aligned with industry needs.

Keywords: Industry 4.0, textile manufacturing, light industry, artificial intelligence, internet of things, industry transformation map, echnical and vocational education and training.

Introduction. Modern economic conditions put before the management of enterprises the task of ensuring and planning competitiveness, which is inextricably linked with the activities of introducing innovations, including in production processes. The expected effects from the introduction of innovative technologies are the acceleration of the production cycle and the reduction of production costs, which will undoubtedly lead to an increase in the financial profit of the enterprise [1]. And if cost reduction often cannot be corrected and depends on external factors, then technological improvement and acceleration of the product production process can be constantly worked on. Each new generation of breakthrough technologies has its own unique power, it is the collective potential of these technologies to increase the productivity and quality of goods and services that has the greatest prospects for influencing public value and influence [2].

Blurring the boundaries between the physical, digital and biological worlds, 4IR technologies, including artificial intelligence, robotics, the Internet of Things, 3D printing, genetic engineering, quantum computing and machine learning are rapidly becoming indispensable in modern working life, and in the daily lives of citizens.

And most importantly, the question is not how to prepare for 4IR technologies in the near future, but how to help individuals, enterprises and higher education institutions use them effectively to increase productivity and competitiveness today.

The rapid introduction of technologies of the Fourth Industrial Revolution (4IR) will create an additional 100,000 jobs in the textile industry in Uzbekistan, which have significant untapped growth potential [4].

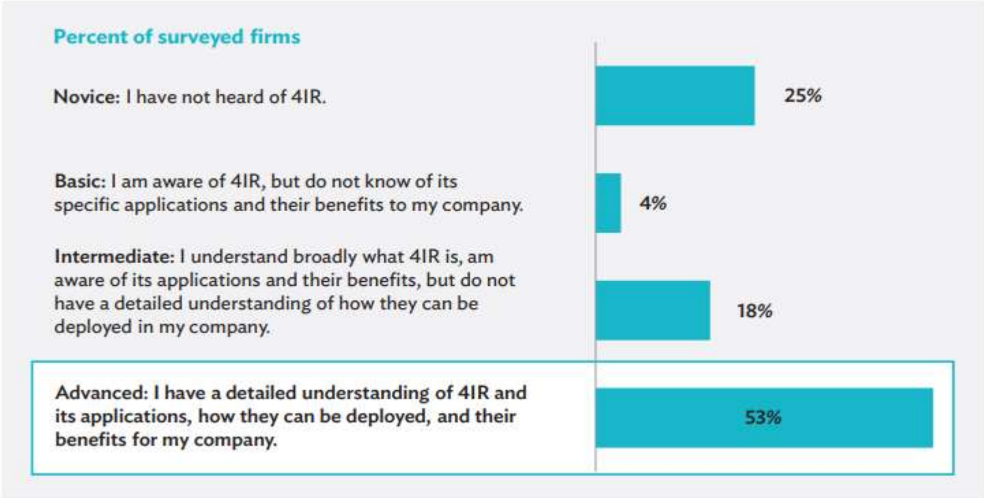
Research methods and techniques. Modern production sets its main task not only to manufacture high-quality consumer products for the market, but also to maximize efficiency and, as a result, profitability of production. Given the pace of active introduction of digital technologies among foreign companies, domestic enterprises are gradually coming to understand the inevitability of digital transformation and digitalization of production. Automation of production at modern light industry enterprises is one of the leading areas of digital transformation, since the introduction of automation tools leads to increased efficiency and lower costs by reducing production costs [5].

The technologies of the Fourth Industrial Revolution open up significant potential for textile and clothing enterprises to increase labor productivity. According to analysts, the full implementation of Industry 4.0 technologies in the textile and clothing industry, the production value chain can reduce working hours by 40-70% [6]. Statistical forecasts show that the industry of Uzbekistan meets these expectations. Textile manufacturers have a good

The decisive link in the use of 4IR technologies is the investment of personnel in skills such as artificial intelligence, the Internet of Things, robotics, machine learning, 3D printing, genetic engineering and others [4]. The coronavirus pandemic (COVID-19) caused an intrusion into business processes, which led to the acceleration of the introduction of digital solutions in the market. Due to the growing digital talent gap, organizations in both the public and private sectors need to invest in retraining and advanced training for new and transforming jobs through the introduction of technology.

understanding of current technologies, with 53% reporting a deep understanding of Industry 4.0 and its applications. According to the survey, firms expect labor productivity to increase by an average of 68% by 2025 with the introduction of 4IR technologies (Fig.1).

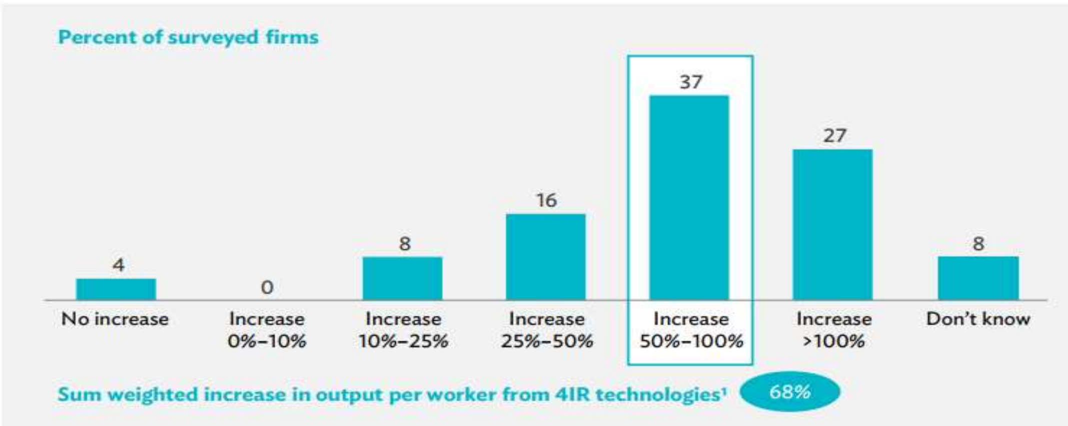
A good awareness of Industry 4.0 technologies is supported by government policies aimed at encouraging textile producers in Uzbekistan to introduce innovative production methods. Especially, the 2017 Presidential Decree “On measures to accelerate the development of the textile, clothing and knitwear industry” (UZ Daily 2017) establishes measures to modernize production processes; introduce advanced information and communication technology (ICT) technologies; and to introduce international standards to improve product quality in the textile industry. Despite the many benefits of new technologies, more than a quarter of the SMBs surveyed have limited understanding of Industry 4.0 technologies. Despite the fact that SMEs make up a significant part of the economy of Uzbekistan, employing about 80% of the labor force (OECD, 2017). Therefore, it is necessary to adopt targeted programs to ensure the distribution of 4IR technologies in this sector.



4IR = Fourth Industrial Revolution.
Note: Based on survey of employers in the textile and garment manufacturing industry between June and September 2021 (n=51).
Source: Asian Development Bank (Sustainable Development and Climate Change Department).

Fig. 1. Understanding of Industry 4.0 technologies by entrepreneurs in the textile and clothing industry in Uzbekistan

In accordance with the deep development of Industry 4.0 technologies and their application, the textile industry of Uzbekistan expects that new technologies will bring a significant increase in productivity. According to the analysis of the study, thanks to the introduction of appropriate technologies in the textile and clothing industry, productivity can be increased by 21-46%. In the textile industry of Uzbekistan, companies are more optimistic and expect an increase in labor productivity by an average of 68% by 2025 with the introduction of 4IR technologies (Figure 2).

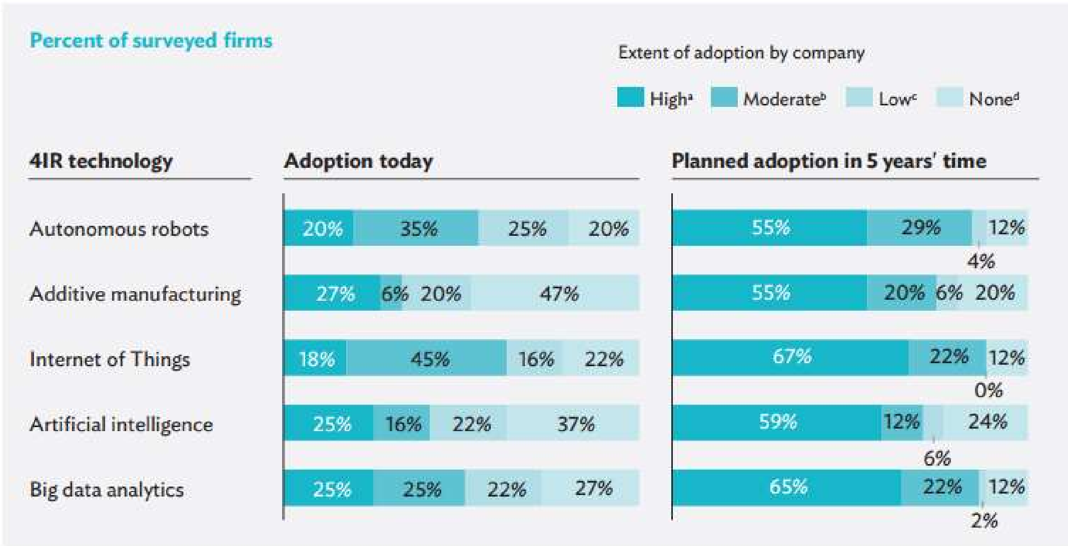


4IR = Fourth Industrial Revolution.
Notes: Based on survey of employers in the textile and garment manufacturing industry between June and September 2021 (n=51). Calculated using sum-weighted average of output increase by the number of firms indicating different levels of expected increase in output, i.e., 0%, 0%–10%, 10%–25%, 25%–50%, 50%–100%, and over 100%. The midpoint of the range for each option for expected increase in output is used; for expected output increase of over 100%, the lower bound of 100% is used.
Source: Asian Development Bank (Sustainable Development and Climate Change Department).

Fig. 2. Expected increase in work efficiency due to Industry 4.0 technologies in the textile and clothing industry of Uzbekistan, 2020-2025

High hopes for labor productivity growth correspond to the plans of firms to

significantly expand the introduction of Industry 4.0 technologies over the next years. (Figure 3). Automated systems demonstrate the highest level of implementation among the surveyed firms; it is assumed that by 2025 the introduction of Artificial Intelligence technologies, the Internet of Things and big Data analytics will increase several times. Currently, 80% of the surveyed firms in Uzbekistan more or less use autonomous robots. For example, ARTEX Group, one of the largest textile companies in the country, uses fully automated yarn and fabric dyeing processes [6].



4IR = Fourth Industrial Revolution.

[a] "High": Firm has fully deployed the technology across all possible functions in the enterprise and/or has plans to fully deploy the technology across all possible functions in the future.

[b] "Moderate": Firm has implemented the technology, but not fully deployed across all possible functions in the enterprise and/or plans to implement the technology across a few functions in the future.

[c] "Low": Firm is experimenting with the technology at a limited scale within the enterprise and/or plans to experiment with the technology in the future.

[d] "None": Firm has not used technology at all within the enterprise and/or has no plans to use the technology in the future.

Note: Based on survey of employers in the textile and garment manufacturing industry between June and September 2021 (n=51).

Source: Asian Development Bank (Sustainable Development and Climate Change Department).

Fig. 3. Comparative analysis of the introduction of 4IR technologies in the textile and clothing industry in Uzbekistan

Research results and discussion. Now consider some applications of Industry 4.0 technologies, external relation to the textile industry: robotics and smart manufacturing, 3D printing and knitting, virtual and augmented reality, and artificial intelligence.

Robotics and smart manufacturing. Advanced technologies in the textile industry have brought a new vector to smart manufacturing, referred to as smart factories, thereby further pushing the boundaries of traditional automation [7]. Benefits of data-driven manufacturing using Dig Data technologies can organize production more flexibly and efficiently by collecting and analyzing real-time data from connected production systems, in addition to existing data. These latest technologies are helping businesses adjust more flexibly to the current competitive world by giving them the advantage of being able to predict supply and demand, eliminating supply chain-related problems in a timely manner [8].

In the text industry of the development of robotics, the automation of accidents in this area of labor-intensive

work, like sewing, has come. With the help of machine vision, sewing robots can detect fabric defects and make the necessary adjustments [9]. For example, Tianyuan Garments, the main manufacturer of branded sportswear such as Reebok and Adidas, has fully automated the T-shirt production line, using robots to cut out fabrics and sew T-shirts in a matter of minutes [10].The company also uses work in the warehouses of the enterprise to increase the flexibility and speed of delivery.

3D knitting and 3D printing. Another of the modern technologies in the field of textiles, 3D printing, or the so-called additive manufacturing, creates 3D objects from a digital file. This is a new additive manufacturing process that is created by adding successive layers to a material called filaments [11]. This is a print head or extruder technology that fuses a filament that turns into a 3D model of the product. Another use is 3D knitting, using knitting needles to recreate entire pieces of the required piece of fabric, preventing production waste [12]. Both of these technologies increase efficiency in production by configurable reducing manual labor and production processes.

3D printing and 3D knitting technologies are used for productivity and hyper-personalization. They reduce waste, lead times and manufacturing costs by minimizing manual labor and simplifying the manufacturing process [13]. The troublesome work oriented to the desire of individual clients, hyper-personalization and digitization, which required more time and money for the entrepreneur, is also solved by 3D knitting.

Augmented and Virtual reality. Virtual Reality (VR) technology creates a digital real environment that is almost indistinguishable from the natural environment. This artificial environment helps reproduce the desired image without leaving the room [14]. And, augmented reality (AR) technology, by adding the desired content to the real environment by the computer, helps to mix the digital and physical world.

The use of VR and AR technologies opens up incredible opportunities for textile and clothing manufacturers. The flexibility of technology contributes to hyper-personalization, buyers can try on clothes without leaving home, order certain models for different tastes, or add the desired attributes to an existing model.

Artificial intelligence (AI). Artificial intelligence (AI) is an area of machine learning where machines mimic human cognitive functions such as pattern recognition, sensation, and learning [15]. Artificial intelligence manages a set of algorithms with the help of a computer, processing and recognizing limitations in large amounts of data. Based on this data, he can predict, correct errors, select panels, make recommendations, and others [16].

One of the differences between AI and humans is that it is able to process any big data quickly and reliably. Consequently, new technologies make extracting information from big data a more flexible, cost-effective process, increasing scalability [17]. Explore and analyze customer database AI can simplify many corporate tasks, from pricing to product recommendations [18].

The possibilities of AI are endless, predicting trends in the textile industry, AI makes it possible to automate a number of top management tasks, such as decision making in production, marketing, product pricing, process chain adjustment, smart use of enterprise warehouses, development of new products based on demand, and others [19].

Another of the possibilities of AI is deep personalization for the client, analyzing personal data and based on the uniqueness of the style, wardrobe of clothes, AI recommends to buyers the appropriate size, color, style of clothing [20]. It also recommends products with

individual preferences based on past purchase history and customer reviews.

Conclusion. As a result of the study of modern sources in relation to the experience of past years, it became obvious that the introduction of Industry 4.0 technologies in the textile and clothing industry can not only cause job losses, but also the basis for the emergence of new professions, usually more high-tech and highly paid. Forecasts in the textile industry of Uzbekistan prove that the use of 4IR technologies will increase labor productivity by an average of 68% by 2025.

With the growing digital talent gap, organizations in both the public and private sectors need to invest in reskilling and upskilling for new and transforming jobs. This requires closer cooperation between higher education institutions and industry in order to supply highly qualified personnel to our developing economy.

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UDK 312.1

METHODOLOGY FOR ASSESMENT OF EXTERNAL FACTORS AFFECTING THE FINANCIAL SECURITY OF BUILDING MATERIALS INDUSTRY ENTERPRISES

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Abstract:

Objective. This article analyzes the external factors affecting the financial security of construction materials industry enterprises and reveals the specific features of the construction industry in ensuring financial security at the micro level. The author has thoroughly analyzed the world's existing methodology for assessing the financial security of the enterprise. Taking into account that the method of determining the level of financial security of the enterprise based on the assessment of the internal and external environment is universal, it can be used in construction industry enterprises, taking into account the specific characteristics of the construction industry network.

Methods. The methodological foundations of the financial stability of enterprises, its gradual increase by improving the financial management, the development of the financial strategy of enterprises, and the assessment of financial stability were theoretically studied through the methods of scientific abstraction and observation.

Results. During the research, local economist B. Tursunov adapted the external environment assessment criteria to the construction industry, including: the stability of the banking system, the development of mortgage loans, competition in the domestic market, and factors such as the demographic situation in the country, which are considered to be the main factors that shape the demand for housing.

Conclusions. In the scientific work, the methodology for assessing the financial security of previously existing enterprises was supplemented with criteria taking into account the specific characteristics of the construction industry. This methodology is based on the application of the scoring method and uses weighting coefficients. It allows to determine the level of effectiveness of the management process of ensuring financial security in construction industry enterprises.

Keywords: building materials industry, enterprise, financial security, profitability, risk.

1. Introduction. In the development strategy of the new Uzbekistan for 2022-2026, special attention is paid to "increasing the gross domestic product per capita - 1.6 times and the production volume of industrial products by 1.4 times".[1] The consistent and effective performance of these tasks will ensure the financial stability of enterprises in the country, reduce the level of bankruptcy, identify investment risks, as well as implement investment projects of enterprises, make investment projects and investment decisions, internal and external threats to the financial security of the enterprise, assess the value of the enterprise's assets, liquidity coefficient , analysis of solvency, profitability level, formation of a single information platform for assessing financial security, provides comprehensive opportunity to use modern methods of ensuring financial security of enterprises.

2. Literature review. Way to improve financial management to ensure financial stability of enterprises with him Methodological foundations of gradual increase, development of financial strategy of enterprises and assessment of financial stability are widely studied in scientific works of foreign authors. Financial security theory issues with A. Marshall [2], J. Mill [3], D. Ricardo [4], A. Smith [5] and others many classical economics theory school representatives engaged in.

Issues of financial security, threats to financial security and strategies to prevent them Amade S.M. [6], Amirsele A. [7], Amore L. [8], Ahmad S., de Deriyan, V. Delas and other scientists have researched.

A number of studies were conducted by economists-scientists of the CIS countries on the problems of assessing and managing the economic and financial security of enterprises, including those based on the concept of competitiveness; development of a management concept implementation mechanism aimed at creating a modern system of financial risk management in credit financial organizations; prevent bankruptcy and merger with another enterprise; analysis of the Monte Carlo model for financial risks; conceptual aspects of financial and economic risk assessment in enterprises; management of financial risks arising in the process of mergers and acquisitions based on mutual cooperation with shareholders; ensuring the financial stability of joint-stock enterprises, developing organizational and economic methods and models for ensuring the financial security of the enterprise, etc.

The issues of ensuring economic security and financial security at the macro and micro levels, their assessment and management are also reflected in the works of our country's scientists - A. Burkhanov [10], K. Abulqosimov and others. Shown the works of the authors undoubtedly add a large share to the theory of ensuring the financial security of the enterprise. But due to the complexity and multifacetedness of the problem of ensuring the financial security of the enterprise, all its aspects have not been sufficiently explored in these studies. Enterprises ensuring financial security and assessing it, foreign qualifications experience Uzbekistan to the conditions customization, enterprises the methodology of ensuring financial security our country to enterprises according to work exit in order to of management common acceptance done methods to apply scientific justification necessity is available.

Delas V., Nosova E. and Yafinovich E. as a group of Ukrainian authors suggest studying financial security indicators based on matching Maslow's pyramid to the hierarchy of business needs. According to this approach, the need for security is one of the main needs, and is in third place after

the idea of financial security and the need to realize it. According to scientists, the evaluation of the level of financial security in such a context should include the following components: the financial security of the company represents certain aspects of its financial situation, and these aspects reflect a certain level of financial security; the financial condition of the company describes its financial support and can be determined using a certain number of indicators; the qualitative and quantitative indicators of the financial security system of the enterprise must be clearly defined.

The community of Western and Asian scientists rarely study financial security indicators, they focus more on separate components: activity risks; level of information security; reliability of financing sources; focus on the assessment of financial autonomy indicators. In our opinion, such methodology has a somewhat subjective nature and allows to assess the level of financial security of the enterprise in relation to the competitive environment, which makes it difficult to understand the development prospects of the business, although it provides a complex.

One of the local economists, B.Tursunov [9], in his scientific work, proposed a comprehensive approach to the assessment of the financial security of the enterprise and proposed to determine the level of financial security of the enterprise based on the assessment of the internal and external environment. This methodology is considered universal and can be used in construction industry enterprises, taking into account the specific characteristics of the industry. Our research is dedicated to solving these issues.

3. Research methodology. Scientific justification of external factors affecting the provision of financial security of enterprises and taking into account the specific characteristics of the enterprise, that is, in which sector it operates and its specialization, should be paid attention to.

Therefore, for the scientific justification of external factors affecting the provision of financial security, an approach based on the specific characteristics and specialization of the studied object (industry and industry) is required.

We determine the external factors affecting the provision of financial security on the example of construction materials industry enterprises. The distinctive features of this industry are as follows:

- inclusion of the network in the structure of heavy industry;
- high fund capacity of enterprises;
- the need for large-scale investments;
- high transport costs;
- that the main market is aimed at satisfying domestic demand;
- the location of the production complex in the area of the raw material base;
- complexity of technological processes;
- high demand for labor force ;
- seasonality of construction material products.[10]

of construction industry enterprises should be evaluated taking into account the influence of external factors. The main threats affecting joint-stock companies can be divided into the following groups: the stability of state policy, specific features of the economic strategy of state development, the country's tax system, market and entrepreneurial freedom, the level of competition and the competitiveness of the economic sector and individual products.

4. Analysis and results. We will study from the point of view of external factors of financial security of joint-stock companies of the Republic of Uzbekistan and assessment of threats to it. In this case, the evaluation is considered as a component of the general methodology for each enterprise.

The country is on the way to industrialize the economy, improve the standard of living and modernize the society. As a result, in the last 4 years, the GDP growth rate has reached almost 6% per year, which indicates that the market's political and economic situation is improving and a stable development situation is forming.

Local economist B.Tursunov [9] adapted the external environment assessment criteria to the construction industry, including: the stability of the banking system, the development of mortgage loans, competition in the domestic market, and the demographic situation in the country, which are considered to be the main factors that form the demand for housing.

International indices help to assess the level of political stability in the country. In particular, the World Bank annually publishes the Public Administration Quality Index (*WGI*). The index covers 200 countries and is based on six sub-indices: political stability and absence of violence, quality of regulation, rule of law, accountability of government to the people, effectiveness of government, control over corruption. According to the World Bank, in the last ten years, the Republic of Uzbekistan has been among the backward countries. However, given the current reforms and reforms, the level of political stability can be considered satisfactory and has prospects for improvement.[9]

Table 1

Criteria for assessing the level of financial security of construction industry enterprises in the external environment

Factors	The state of the external environment	Grades	Expert assessment	Weight factor
The stability of the political situation	Stable	5	5	0.30
	positive reform	4		
	In unsystematic reform	3		
	Unstable	2		
	Not sure	1		
Tax policy of the country	Liberal	5		0.15
	Minimization of taxes	4		
	Socially oriented	3	3	
	Focused on filling the budget	2		
	Development of the country at the expense of tax revenues	1		
Currency policy of the country	A freely convertible stable currency	5	5	0.1
	Stable currency	4		
	Conditionally convertible stable currency	3		
	Unstable currency	2		
	Constant inflation	1		
Stability of the banking system, mortgage loans development	What is the banking system ? developing , globalized , integrated into the international financial community, developed mortgage system	5		0.15
	Dinami k developing, developed mortgage system	4		
	R is developing, the mortgage system is developing	3	3	

	Stable, mortgage system development is lower	2		
	Unstable, underdeveloped mortgage system	1		
Competition in the domestic market	There is healthy competition in the construction market	5	5	0.1
	Healthy competition is high in the construction market	4		
	There are many elements of competition in the construction market	3		
	There is fierce competition in the construction market	2		
	Absolute monopoly in the construction market	1		
Demographic situation in the country	The rate of population increase is very high	5		0.20
	The rate of population increase is high	4	4	
	The population growth rate is lower	3		
	Population growth is worsening	2		
	There is a threat of population decline	1		
Evaluation of the external environment				Кташқи м.

Author development

In the course of the study, it was proposed to increase their profitability as a direction to increase the financial stability of the construction industry enterprises studied as an object, and ultimately to use the production capacities of the enterprise as a lever to ensure their financial security .

Thus, in the scientific work, the methodology for assessing the financial security of previously existing enterprises was supplemented with criteria taking into account the specific characteristics of the construction industry. This methodology is based on the application of the scoring method and uses weighting coefficients. It allows to determine the level of effectiveness of the management process of ensuring financial security in construction industry enterprises .

5. Conclusions and suggestions. In order to determine the external factors affecting the financial security of enterprises of the construction materials industry, first of all, it is necessary to develop the relevant documents for the enterprise, as well as the criteria that can be considered as a violation of the financial security of the enterprise. In other words, the criteria should be defined that allow to assess the compliance with the requirements of financial security of enterprises. For this, financial security services or departments should be opened in construction materials industry enterprises. The financial security service evaluates the compliance with these criteria and communicates the information to the top management of the enterprise.

In addition, an information system should be created for comprehensive and objective monitoring, including the identification and forecasting of internal and external threats to the financial security of the enterprise. Based on the received information, it is necessary to develop a set of quick and long-term measures to fight against negative factors, as well as to

prevent and eliminate possible negative consequences of threats.

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"SCIENTIFIC AND TECHNICHNICAL JOURNAL OF NAMANGAN INSTITUTE OF ENGINEERING AND TECHNOLOGY"

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JURNALI

The editorial was typed and paginated in the computer center
Paper format A4. Size 18,75 conditional printing plate

The copy must be taken from the "Scientific and Technical Journal of the Namangan Institute of Engineering and Technology"